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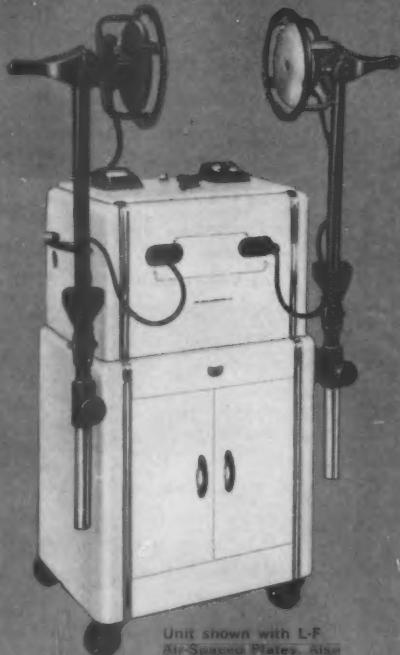


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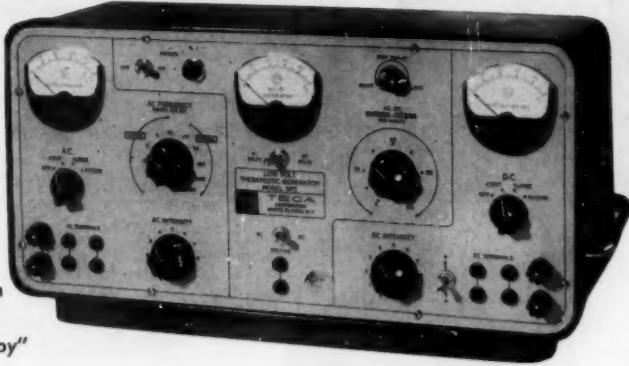
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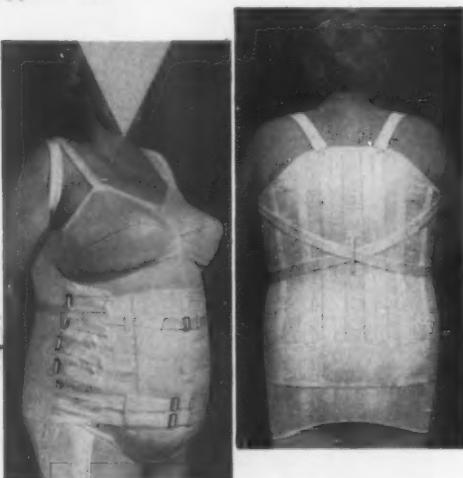


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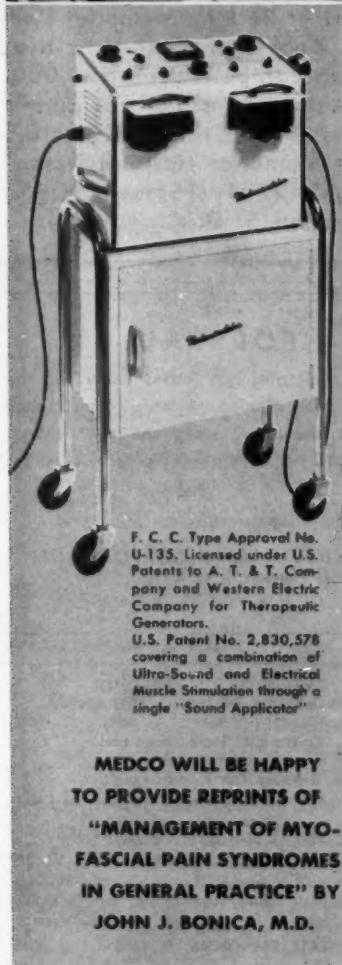
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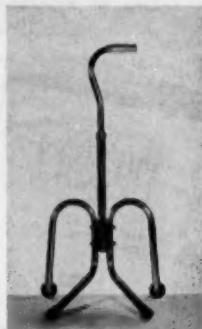
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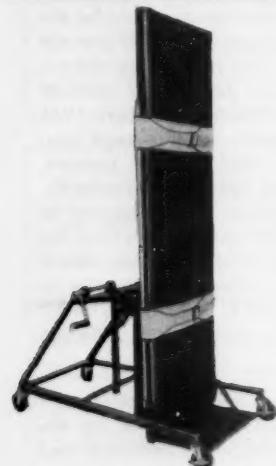
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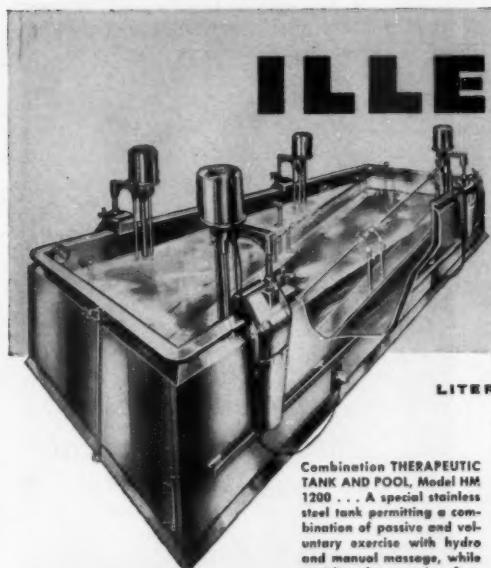
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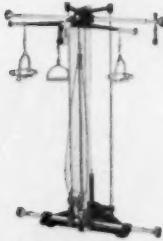


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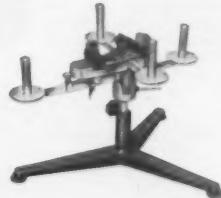
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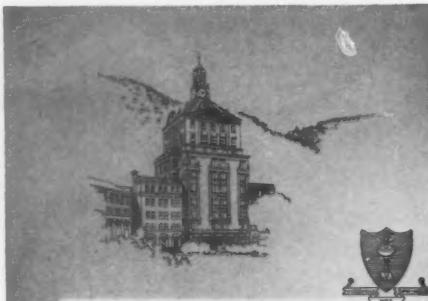
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Relief of Arthritic Pain and Rehabilitation of Chronic Arthritic Patient by Extended Sympathetic Denervation

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and

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● Pain arising in the weight-bearing joints is the major source of disability presented by most patients with chronic arthritis. The difficulty in alleviating joint pain, permanently and consistently, is the principal obstacle to the rehabilitation of these patients. During the past 3½ years, the authors have employed a surgical technic of so-called extended lumbar sympathectomy in a group of some 15 unselected patients with advanced rheumatoid arthritis and osteoarthritis of the hip and/or knee joint. The operative procedure consists of an ipsilateral retroperitoneal lumbar sympathetic denervation encompassing the lumbar sympathetic trunk distal to the crus of the diaphragm, accessory sympathetic ganglia, and decussating fibers in the prevertebral lumbar plexus. The surgery, in this group of middle-aged and elderly patients, has had no morbidity and no mortality. In the immediate postoperative period, these patients exhibited remarkable, effective, consistent, and lasting relief of joint pain with concomitant improvement in joint mobility and in general functional capacity. These patients have been followed for periods up to four years postoperatively and, in all instances, the relief of joint pain and improved mobility have persisted. There have been no untoward effects noted in the follow-up period to date. Charcot arthropathy has not occurred nor is it anticipated.

The major disability of the patient with chronic osteoarthritis or rheumatoid arthritis of the weight-bearing joints is referable to joint pain. Limitation of joint motion, in itself, is usually of lesser import and is for the most part a function of the pain.

Over the course of the past several decades, many attempts have been made to evolve a consistently effective modality for the relief of intractable arthritic pain in the hip, knee, and ankle joints. The high hope held for the most recent additions to the rheumatologist's armamentarium, notably the corticosteroid and prednisone compounds, has not been fully realized.¹⁻³ Their beneficial effects are but temporary and not without undesirable side effects. Where both medical and physiatric regimens fail to afford relief from joint pain, surgical intervention has been tried.

The orthopedic procedures employed for the relief of arthritic pain have included synovectomy, osteotomy, tenotomy, arthrodeses, and arthroplasty. It would appear that while each of these procedures has been of some value in some patients, the functional result of each technic is unpredictable and in

most patients joint pain is not alleviated significantly.

Various denervation operations have also been used for this purpose. The usual neurosurgical operations advocated have been peripheral neurectomies which are predicated on the assumption that the major sensory innervation of joint surfaces is derived from the peripheral spinal nerves. Peripheral neurectomy, the most common being obturator neurectomy for hip pain, has in general failed to provide significant lasting relief.⁴⁻⁶ Spinothalamic cordotomy has afforded pain relief in some patients; however, this technic sometimes causes postoperative urinary retention and the late complication of trophic changes in the denervated areas.⁷ As with peripheral neurectomy, cordotomy produces varying degrees of somatic motor and sensory disturbances by interfering with muscular and cutaneous innervation.

Conventional lumbar sympathectomy has been employed cursorily in several small series of arthritic patients, usually in the presence of vascular insufficiency.⁸⁻¹¹ In the most recent study, White and his colleagues were not favorably impressed by the results of conventional sympathectomy in five patients with rheumatoid arthritis.¹²

Residual and recurrent sympathetic activity have been demonstrated by several observers in patients who had undergone conventional lumbar sympathetic ganglionectomy.¹³⁻¹⁵ Accessory sympathetic ganglia and decussating cross com-

Read at the Thirty-sixth Annual Session of the American Congress of Physical Medicine and Rehabilitation, Philadelphia, August 26, 1958.

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municating fibers, not encompassed in the usual lumbar sympathectomy, have been demonstrated and were thought to be the reason for incomplete sympathetic denervation.¹⁶⁻¹⁹ In order to include these anatomic variations and thereby prevent residual or recurrent sympathetic activity, a technic of extended lumbar sympathetic denervation has been employed recently in patients with intractable arthritic pain in the weight-bearing joints in the absence of vaso-motor insufficiency.^{20, 21} It is suggested that this procedure provides relief of joint pain, in both rheumatoid arthritis and osteoarthritis, by the ablation of afferent pain pathways running from the articular surfaces of the lower extremities and traversing the lumbar paravertebral sympathetic trunks and the retroaortic plexus.^{20, 21} Extended lumbar sympathetic denervation consists of a retroperitoneal ipsilateral excision of the lumbar sympathetic ganglia and intervening trunk from the crus intermedium of the diaphragm distally to the superior margins of the common iliac vessels; accessory ganglia are included in the resection by the division of the rami communicantes as far laterally as possible in the psoas muscle border. The procedure is completed with division of the decussating fibers in the retroaortic prevertebral plexus by multiple crosshatch incisions of the periosteum over the anterolateral aspect of the third and fourth lumbar vertebrae after mobilization and retraction of the abdominal aorta on the left and the inferior vena cava on the right.

Postoperative sweating patterns carried out on these patients reveal anhidrosis of the denervated extremity consistent with the removal of the first, second, third, and fourth sympathetic ganglia. Moreover, patchy areas of anhidrosis in the contralateral thigh confirm the presence of decussating fibers in the lumbar sympathetic trunks. Other than by the use of sweating pattern determinations post-operatively, we have been unable to establish accurately the level of denervation. In our hands, observations at the operating table are of no value because of the gross variation in size, number, and location of the ganglia in the lumbar region.

In the past 3½ years, we have had the opportunity of carrying out extended lumbar sympathetic denervation in some 15 patients with advanced arthritis, and intractable pain, in the weight-bearing joints.

Case Histories

Case 1. A 63-year-old woman had had progressive generalized rheumatoid arthritis since the age of 45. When seen for the first time in January, 1955, she had been unable to walk or stand by herself for the previous two years and was unable to turn on her side in bed without assistance because of pain and immobility of the hips, knees, and ankles. She had run the gamut of treatment including corticosteroids, salicylates, opiates, and physical therapy. Examination revealed continuous pain at rest and complete limitation of motion at hips, knees, ankles, elbows, and wrists. The patient was confined to bed in which she lay with elbows, hips, and knees in attitudes of partial flexion. On January 19, 1955, an extended right lumbar sympathetic denervation procedure was carried out. On the first postoperative day, the patient stated she was free of pain in the right hip, knee, and ankle; limited, active, painless motion at these joints was possible. On January 31, 1955, a similar procedure was carried out in the left lumbar area with similar results.

When last seen in June, 1958, 3½ years after surgery, the patient was ambulatory without support and was doing her own light housework. She volunteered the information that she had not had any pain in the hips, knees, or ankles since January, 1955. She had noted recurrent rheumatoid activity, with painful swelling, in the wrists, elbows, hands, and shoulders in the three years since surgery, following upper respiratory infections.

Case 2. A 72-year-old woman was seen in April, 1955, with a 40-year history of intermittent pain and swelling in the right knee. Weight bearing had not been possible for the previous four weeks. The patient refused further medication, having received phenylbutazone, cortisone, and metacortandracin. X-ray stud-

ies of the right knee revealed marked hypertrophic changes with osteophyte formation and thinning of the joint cartilage. On examination, an exquisitely tender, swollen, right knee was noted. The patient, complaining of pain in the part at rest, refused to permit passive motion. There was some 10 degrees of active flexion.

On April 19, 1955, an extended lumbar sympathetic denervation was carried out on the right side. Upon recovery from anesthesia, the patient was free of pain at rest in the right knee, and demonstrated 60 degrees of active flexion. When last seen in May, 1958, three years later, she stated she had been free of pain in the right knee for three years and was ambulatory without support. At this time 110 degrees of active flexion was noted.

Case 3. A 78-year-old man was first seen in December, 1955, with a 13-year history of painful osteoarthritis of the right hip. For the 6 months before admission, the pain in the right hip was severe and did not respond to analgesics or physical therapy. Examination revealed some senile personality changes. The patient was confined to bed and could neither stand nor walk. There was 45 degrees of active painful flexion at the right hip joint. X-ray examination revealed changes indicative of malum coxae senilis with decrease in the joint space and osteophyte formation.

On December 27, 1955, an extended lumbar sympathetic denervation was performed on the right side. On the first postoperative day, the patient was free of pain at rest and on weight bearing. When last seen in January, 1958, three years later, he was completely ambulatory without support and was walking two miles daily without pain. Examination at this time revealed 130 degrees of active painless flexion and 30 degrees of active painless abduction.

Case 4. A 62-year-old spinster was seen for the first time in February, 1956, with a 2-year history of pain, stiffness, and swelling in the right knee. The pain, present at rest, was aggravated by weight bearing. Roentgenographic examination revealed that this knee was the site of moderate osteoarthritic changes.

On February 21, 1956, an extended sympathetic denervation was carried out in the lumbar area. On the first postoperative day, the patient was free of pain at rest and on weight bearing. Two years after surgery, she was ambulatory without support and had had no complaints referable to the right knee since surgery.

Case 5. A 56-year old woman was seen in consultation in March, 1956, with a 7-year history of generalized progressive rheumatoid arthritis. For the previous 5 months she had been unable to stand or walk by reason of pain in the right knee. She had received the benefit of intensive physical therapy, salicylates, phenylbutazone, and corticosteroids without significant lasting relief. Examination revealed obvious rheumatoid arthritic deformities of the joints of all four extremities. The right knee was tender and had 80 degrees of painful active flexion; the right hip, 45 degrees of painful active flexion.

On March 26, 1956, a right, extended, lumbar sympathetic denervation was carried out. On the first postoperative day, the patient remarked on the absence of pain at rest in the right hip and knee joints. On the third day after surgery, the patient could stand on the right leg without pain. When last seen in February, 1958, she was free of pain in the right knee and right hip at rest and on standing. The right knee had 100 degrees of pain less active flexion; the right hip, 90 degrees of painless active flexion.

Case 6. A 49-year-old woman was seen in consultation in May, 1956. She had noted the onset of recurrent rheumatoid arthritis in both wrists, fingers, and right knee some 6 years previously. The right knee had been the site of painful swelling more or less continuously since 1950.

Examination revealed a red, tender, swollen, warm, right knee with 45 degrees of painful active flexion. Weight bearing was limited because of pain in the right knee. Treatment with salicylates, corticotropin, and hydrocortisone had not afforded the patient significant relief. A secondary tonsillectomy had been resorted to in 1952, to no avail.

On May 8, 1956, the right lumbar sympathetic chain was exposed surgically and found to be covered in its proximal extent by anomalous, multiple, large lumbar veins. The lumbar trunk was resected up to the level of the third lumbar vertebra above which point it could not be safely removed without entailing the risk of uncontrollable hemorrhage. Post-operatively, the patient felt essentially no change in the pain in the right knee.

Case 7. A 75-year-old widow actively engaged as a medical secretary had an 8-month history of pain and swelling in the right knee when seen in August, 1956. The pain, moderate at rest, became more severe on standing and walking. Examination revealed a painful, tender, swollen, right knee with 60 degrees of active painful flexion. X-ray examination revealed advanced hypertrophic osteoarthritis with osteophyte formation and narrowing of the joint space.

On August 20, 1956, a right, extended, sympathetic denervation was carried out in the lumbar area. On the first post-operative day, there was no pain at rest and the patient could stand and walk without pain in the right knee. When examined in March, 1958, 20 months after surgery, the patient had no complaints and was walking actively at her work 6 days a week. The knee had 110 degrees of painless active flexion.

Case 8. A 74-year-old man was seen in May, 1957, with advanced painful osteoarthritis of the left hip for the previous 3 years. Intra-articular instillation of hydrocortisone, salicylates, and opiates had been prescribed without significant relief. An obturator neurectomy on the left had failed to relieve the pain. Arthrodesis of the joint by means of an iliac crest bone graft had failed due to pseudarthrosis formation. Dorsal spinothalamic cordotomy had provided relief of pain for but 6 months.

The patient was ambulatory on crutches but refused to bear weight on the left foot because of continuous pain in the left inguinal and left thigh regions. There was 5 degrees of painful passive flexion and abduction at the left hip. Extended lumbar sympathetic denerva-

tion was carried out on May 17, 1957. The patient has been free of pain in the area of the left hip since surgery. When last seen, 12 months after surgery, there was no pain at rest or on weight bearing. There was 5 degrees of painless active flexion at the partially fused left hip joint.

Case 9. A 67-year-old woman was seen in June, 1957, with a 2-year history of pain in the right hip following a fracture of the femoral neck which healed after the insertion of a Smith-Petersen nail. Because of a wound infection and intractable pain in the hip, the nail had been removed. The patient, while lying in bed, refused to permit the examiner to move the limb passively. She was ambulatory on crutches and could not bear weight because of intractable pain in the right hip. The pain in the hip at rest was so severe that active and passive motion were not permitted. X-ray examination revealed hypertrophic changes in the right hip with narrowing of the joint space. On June 26, 1957, extended sympathetic denervation was carried out in the right lumbar area. On the first post-operative day, the patient had no pain at rest. When last seen, 7 months after surgery, she was ambulatory without support and was free of pain in the hip both at rest and on weight bearing. There was 100 degrees of active painless flexion at the hip.

Case 10. A 53-year-old woman presented a 3½-year history of rapidly progressive rheumatoid polyarthritis. For the past 6 months, she had been incapacitated, unable to walk or stand, because of intractable pain in the right hip. Corticosteroids, diet, physical therapy, autogenous vaccines, and the removal of foci of infections had failed to relieve the patient's complaints. The bedridden patient refused to permit the examiner to move the right lower extremity.

X-ray examination of the right hip revealed marked destructive changes with protrusion of the head of the femur through the acetabulum. On July 11, 1957, an extended lumbar sympathetic denervation was carried out on the right side. On the first postoperative day, the patient was free of rest pain in the region

of the right hip and displayed 45 degrees of painless active flexion. She was fitted with an ischial weight-bearing brace to protect the right acetabulum. When last seen in March, 1958, 8 months after surgery, the patient was ambulatory with a cane and the brace and free of pain in the right hip.

Case 11. A 60-year-old widow was first seen in July, 1957, with an 8-year history of generalized rheumatoid arthritis. For the previous 6 months she had been confined to a wheelchair with an active rheumatoid process in the right knee. Gold salts, salicylates, prednisone, and corticosteroids had been prescribed without significant effect. Examination revealed a warm, swollen, tender, red, knee joint with a 90 degree flexion contracture. The patient refused to permit measurement of the extent of passive flexion.

On July 25, 1957, extended lumbar sympathetic denervation was carried out. On the first postoperative day, the patient was free of pain at rest in the right knee. By the third postoperative day, the rubor and swelling of the area had completely subsided and the patient had 20 degrees of active painless flexion.

The patient was left to her own devices at home, and in 9 months the flexion contracture of the knee cleared completely. When last heard from in June, 1958, she was ambulatory without support and free of pain in the right lower extremity. She requested that similar surgery be carried out on the left side.

Case 12. An 81-year-old widow was seen in January, 1958, with a 15-year history of painful osteoarthritis of the right hip. In the 6 months previous, the pain had become progressively more severe so that she could walk for but short distances and this only with a cane. Examination revealed 40 degrees of active painful flexion and 20 degrees of active painful abduction. X-ray examination of the right hip revealed extensive hypertrophic changes in the acetabulum and femoral head. On January 20, 1958, a right, extended, lumbar sympathetic denervation was performed. On recovering from anesthesia, the patient was free of

rest pain and exhibited 120 degrees of active painless flexion at the right hip. In June, 1958, 6 months after surgery, the patient was ambulatory without pain; there was 120 degrees of active painless flexion and 30 degrees of active painless abduction at the right hip.

Case 13. A 54-year-old woman had a 15-year history of generalized progressive rheumatoid arthritis. She had been unable to stand or walk except with crutches for one year because of intractable pain at rest in the left hip. Attempted weight bearing or motion aggravated the pain. She had received salicylates, gold salts, corticosteroids, and prednisone without significant relief. On February 20, 1958, an extended lumbar sympathetic denervation was performed. On the first postoperative day, the patient was free of pain at rest in the left hip joint area and exhibited some 30 degrees of painless active flexion. Four months after surgery, the patient was partially ambulatory without pain in the left hip. She was complaining of stiffness in the left hip and weakness of the muscle groups in the left lower extremity. Her chief complaint was referable to the right knee and right hip.

Case 14. A 58-year-old man presented a 10-year history of pain with swelling in the right knee. A medial meniscectomy had been done on the right knee 10 years previously. There had been no relief of the pain in the right knee with salicylates or opiates. The patient could walk with support for but short distances. Examination revealed a tender, right knee joint with effusion. There was 60 degrees of active painful flexion. X-ray examination of the knee exhibited osteoarthritic changes with some osteoporosis.

On February 24, 1958, an extended sympathetic denervation was carried out in the right lumbar area. On the first postoperative day, there was no pain at rest and the right knee exhibited 100 degrees of active painless flexion. Four months after surgery, the patient had no complaints referable to the right knee.

Case 15. A 68-year-old woman had had painful osteoarthritis of both hips for 20 years. For the previous 2 years, con-

tinuous pain at rest in the left hip had prevented standing or walking for but short periods. Salicylates, codeine, and intra-articular instillation of hydrocortisone failed to provide relief. Examination revealed 60 degrees of active painful flexion and 10 degrees active painful abduction at the left hip. X-ray examination revealed advanced osteoarthritic changes in both hips.

On May 5, 1958, surgery in the form of a left, extended, lumbar sympathetic denervation was performed. On the first postoperative day, the patient was free of pain in the left hip on standing and walking. When last seen, 6 weeks postoperatively, she had no complaints referable to the left hip and requested similar surgery on the right side. The left hip had 100 degrees of active painless flexion and 30 degrees active painless abduction.

Discussion

Each patient in this series, with the exception of case 6, upon recovery from anesthesia on the day of surgery, remarked on the absence of pain in the previously painful joint or joints. There was absence of pain at rest, on weight bearing, and also on limited active motion. The range of painless motion increased progressively each day in the first two weeks postoperatively as the patient became ambulatory for longer periods. The functional capacity of the patient increased for 6 months after the surgery as previously atrophic immobilized muscle groups were utilized once again. In all patients in whom the complete operation could be carried out, the relief of joint pain and the simultaneous improvement in functional capacity have been maintained in the follow-up periods; these range now up to 3½ years after surgery. It is suggested that intensive physical therapy of the atrophic muscle groups about the arthritic joint in the postoperative period would enhance the rapidity of rehabilitation as well as the extent to which these patients may be restored to activity.

These observations would appear to confirm the thesis that the principal sensory innervation of the articular surfaces

of the hip, knee, and ankle joints is derived from the lumbar sympathetic ganglia. Additional evidence for this may be found in the observation of the effects of sympatholytic drugs. Howell²² used tetraethylammonium bromide in a series of 26 patients with rheumatoid arthritis and noted transient diminution of pain. Platt and Steinberg²³ treated 12 rheumatoid arthritis patients with hexamethonium chloride and observed similar relief of joint pain. Kellgren and Samuel,²⁴ finding that pain sensation in the human knee arose from the fibrous articular ligaments and synovial membranes, have demonstrated histologically that the majority of nerve receptor endings in these tissues are autonomic in origin.

It is apparent that the subsidence of joint pain following sympathetic denervation is not a function of an adrenocortical response to nonspecific surgical stress. In the patients with rheumatoid polyarthritis, the only joints exhibiting alleviation of pain were in the extremity denervated. Arthritic pain in other extremities in the same patient remained undiminished. Moreover, the relief of pain has been maintained in all patients far beyond the accepted period of postoperative adrenocortical activity.

Neuropathic or Charcot joints have not been observed in any patient postoperatively. This procedure does not render the arthritic joint insensible to all pain stimuli. Direct injury or indirect trauma in the form of sprains produced centrally appreciated pain. It would appear that the periarticular or extracapsular tissues were not denervated by resection of the lumbar sympathetic trunks. Extended sympathetic denervation relieves, selectively, pain of the arthritic joint at rest and also the intracapsular pain arising in the course of physiological motion and weight bearing. The integrity of the joint structure is maintained, therefore, by the preservation, unimpaired, of all extracapsular protopathic sensation as well as that of intracapsular gnosis sensation such as joint position sense.

In patients with secondary musculotendinous contractures adjacent to the affected joints, the pain, arising from the

contracture persisted in the immediate postoperative period. The contracture exhibited progressive spontaneous release, however, 1 to 6 months after the surgery.

Continuing postoperative serial x-ray examinations of the denervated joints have been carried out. It is our impression that roentgenographic evidence of the arthritic process, be it rheumatoid arthritis or osteoarthritis, has not changed significantly after sympathetic denervation. The effect that this type of surgery has on the histopathology of arthritic joints remains to be determined.

In the patients with active rheumatoid processes, extended sympathetic denervation appears to have a primary suppressive effect on the inflammatory manifestations of rheumatoid activity. An acutely inflamed knee joint within 3 to 4 days of surgery will exhibit marked subsidence of effusion, periarticular swelling, heat, rubor, and tenderness, in addition to the immediate relief of joint pain. Moreover, in two patients with generalized rheumatoid arthritis, upper respiratory infections produced flare-ups of acute rheumatoid activity in joints in all extremities but those in which sympathetic denervation had been carried out previously.

The disability of the patient with advanced arthritis in the weight-bearing joints is the result of articular pain and restriction of joint motion. A significant part of arthritic joint immobility is a function of the pain. Extended sympathetic denervation provides for increased functional capacity, where medical and physiatric modalities have failed, by primarily relieving pain of intracapsular origin and secondarily by diminishing joint immobility.

Summary

Extended sympathetic denervation has been employed for the relief of intractable arthritic pain in the weight-bearing joints in 15 unselected patients over the course of the past 3½ years. In both rheumatoid arthritis and osteoarthritis, this procedure has consistently and safely provided lasting relief from joint pain. Concomitant with the alleviation of pain has been dramatic improvement in the functional capacity of these patients.

It is suggested that extended sympathetic denervation represents the long-sought-for technic for the permanent abolition of arthritic pain in the weight-bearing joints. As such, it is of major import in the rehabilitation of the chronic arthritic patient.

Addendum

Since this paper was submitted for publication, an additional 14 patients have been operated on for intractable arthritic pain in the hip and/or knee joint. All of these more recent patients have noted a similar relief of joint pain following surgery.

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Have you heard . . .

For the first time the World Congress of the International Society for the Welfare of Cripples will convene outside the limits of continental Europe. Immediately following the 3rd International Congress of Physical Medicine to be held at The Mayflower, Washington, D. C., the week of August 21, 1960, The National Society for Crippled Children and Adults, integrating its own annual meeting with the 8th World Congress will host and organize the week-long session to commence on August 29, 1960 at the Waldorf Astoria, New York City. Doctor Howard A. Rusk, Director of the Department of Physical Medicine and Rehabilitation at New York University-Bellevue Medical Center, has been elected President of the 8th World Congress. Doctor Rusk, currently president of the World Rehabilitation fund and immediate past-president of ISWC, will lead the international exchange of latest knowledge and technics contributing toward rehabilitation of the world's physically handicapped. Further information concerning the 1960 World Congress can be obtained from Donald V. Wilson, secretary general, International Society for the Welfare of Cripples, 701 First Avenue, New York 17, N. Y.

Management of the Bladder in Traumatic Paraplegia

Pablo A. Morales, M.D.

and

Robert S. Hotchkiss, M.D.
New York

● One of the consequences of injury to the spinal cord is disturbance of bladder function. The neurogenic bladder in traumatic paraplegia generally expels its contents involuntarily and incompletely. As a result of urinary incontinence, the paralyzed patient becomes uncomfortable, foul-smelling, and socially isolated. Uro-
stasis in the bladder leads to urinary infection, which, if not controlled or eradicated, readily spreads to the upper urinary tract and causes irreparable renal damage. Back pressure from the retained urine may eventually cause dilation of the ureter as well as the pelvis and calyces, and consequently further renal destruction. Stagnation of urine, in combination with other factors related to immobilization, promotes the formation of stones, which not only aggravates infection but also destroys kidney function by obstruction. Thus, the paraplegic individual, although no longer doomed to an early death, faces a long-term prognosis that remains speculative.

The need for assiduous bladder care from the very beginning of paraplegia is of the utmost importance, and its unremitting continuance throughout the paraplegic's life should be emphasized. Many complications may thus be averted and rehabilitation of the patient greatly accelerated.

Normal Bladder Neurophysiology

Bladder innervation consists of parasympathetic, sympathetic, and somatic components (fig. 1). The parasympathetic fibers originate from the lateral horns of the second, third, and fourth sacral segments of the spinal cord and proceed via the pelvic nerve (*nervus erigentes*) to ganglia (pelvic plexus) in and adjacent to the bladder wall. Sympathetic axones from the lateral cells of the lower thoracic to the third lumbar segments also reach the bladder through the presacral nerve (superior hypogastric plexus). Present evidence, however, indicates that the sympathetic innervation is not essential for micturition. The external urethral sphincter and the perineal muscles are somatically innervated by the pudendal nerve's motor fibers derived from the anterior horn cells of the second, third, and fourth sacral segments. Sensory impulses from the bladder and other structures concerned with micturition travel in corresponding autonomic and somatic afferents.

A spinal integrating center is located in the sacral segment of the cord and a

higher center exists in the paracentral lobule of the brain. The spinal reflex arc for micturition is formed by the sacral center and afferent and efferent limbs which travel in the pelvic nerve. Pathways which course through the dorsolateral columns of the cord connect the cortical and spinal centers.

Micturition involves a basic reflex act, partly under voluntary control. As the bladder gradually fills with urine, the detrusor muscle fibers at first contract, then relax to accommodate the greater volume. The nature of detrusor response reflects the inherent ability of smooth muscles to maintain tone and resist stretch. As the urine continues to collect, a certain point of filling is reached when distention and the desire to void are recorded by the sensory parasympathetic endings in the detrusor. The stimuli are transmitted to the reflex center for micturition in the sacral cord. In the normal individual, if the time and place are not proper, completion of the reflex act can be interrupted and voiding postponed by release of a stream of inhibitory impulses from the cortical center and voluntary contraction of the external urethral sphincter. When micturition is desired, the higher level inhibition is suppressed and reflex detrusor contraction occurs smoothly and powerfully in tonic action. The internal urethral sphincter, which is normally closed, now reciprocally opens, and urine enters the posterior urethra. Relaxation of the external urethral sphincter follows, and expulsion of the bladder contents is accomplished. Contraction of the abdominal and diaphragmatic muscles and relaxation of the perineal muscles also play a role in the voluntary act of voiding.

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This study was supported in part by a research grant (B-374C) from the National Institutes of Health, United States Public Health Service.

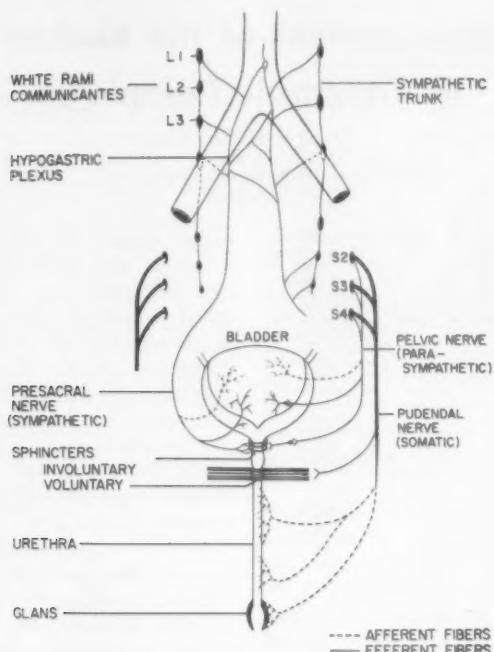


Fig. 1 — Diagrammatic representation of bladder innervation.

Bladder Disturbances in Paraplegia

Atonic Bladder. Immediately after a spinal cord injury, the bladder is under the influence of spinal shock. An atonic type of bladder develops, characterized by atonicity of the bladder wall and loss of reflex detrusor contractions. The bladder becomes distended and overflow incontinence ensues when the limit of distensibility is reached. Some investigators, however, believe that the bladder in this stage is not really flaccid but retains its inherent smooth-muscle tone.¹

As the patient gradually recovers from his spinal shock, he usually acquires either an automatic or an autonomous bladder, depending on the level of the injury. If the spinal cord transection is partial, he develops a voluntary neurogenic bladder although inefficient vesical function may persist.

Automatic Bladder. The automatic bladder, sometimes termed "reflex bladder," occurs when the injury is located above the undamaged sacral center for micturition. The patient has no control over the act of micturition. Urination

occurs reflexly at intervals of up to three or four hours, but sometimes hourly or less. During the intervals between voidings, there is usually no leakage of urine.

Autonomous Bladder. The autonomous or nonreflex bladder occurs when there has been an injury to the sacral spinal segments with destruction of the center for micturition. The reflex arc for micturition is no longer intact and any contraction of the bladder wall is the result of impulses transmitted through an intrinsic nervous mechanism that lies wholly within the bladder wall. Such contractions, however, are of insufficient strength or duration to empty the bladder efficiently. Evacuation of the bladder is accomplished by abdominal straining and manual compression.

Regardless of level, a complete transection of the cord is followed by inability to recognize the normal desire for urination because of interruption of the sensory pathways to the brain. However, vague sensations of fullness may remain in the form of burning or ill-defined painful sensations in the suprapubic area

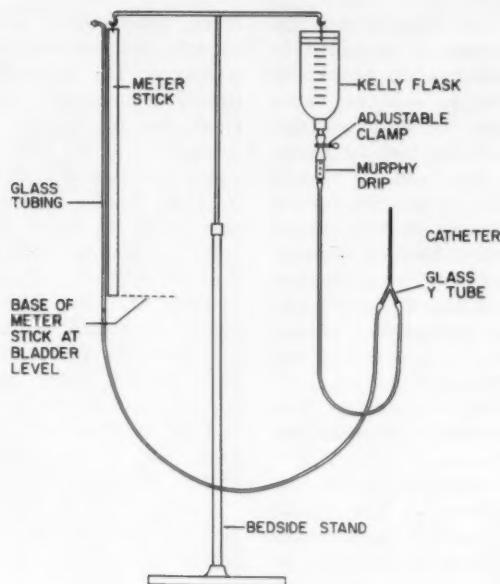


Fig. 2 — A simple cystometer.

or urethra. These are probably mediated through the sensory sympathetic innervation perhaps originating in the peritoneal reflection over the bladder. In lesions above the sixth and fifth dorsal segments and especially in high cervical injuries, the sensations of fullness completely disappear and are replaced by pathologic autonomic manifestations characterized by flushing of the face, profuse sweats, chilling, headache, "goose pimples," and paroxysmal hypertension.

After partial transection of the spinal cord, there usually is some degree of sensation and voluntary motor power. Bladder function may be normal or almost normal with precipitate micturition or stress incontinence. However, in a considerable percentage of patients with incomplete cord lesions, it is not unusual to encounter a small spastic bladder associated with spasms of the lower extremities.

Urologic Examination

Evaluation of the type and degree of vesical dysfunction and its complications necessitates a complete survey which includes cystometry, cystoscopy, cystourethrography, intravenous pyelography,

estimation of residual urine, and urinalysis. None of the examinations is sufficient in itself; they must be interpreted in context.

Cystometry. Cystometry is a procedure designed to graphically record vesical activity during the introduction of fluid into the bladder. The following data may be obtained during the procedure: (1) intravesical pressure in relation to bladder volume, (2) presence or absence of reflex contractions of the bladder muscle and measurement of their amplitudes, (3) maximum voluntary intravesical pressure during abdominal straining, (4) presence or absence of vesical sensation, and (5) bladder capacity.

Various types of instruments for cystometry have been devised. However, a simple model consisting of a water manometer connected by a Y-tube to a fluid reservoir and an indwelling catheter is sufficient (fig. 2). Fluid is introduced into the previously emptied bladder in 25 cc. increments at intervals or at a constant rate of approximately 75 to 100 drops a minute. Manometric pressure levels are recorded after each

25 cc. of fluid have dripped into the bladder. The patient is instructed to inform the examiner when he experiences: (1) desire to void or vague sensation of fullness, (2) autonomic side effects such as headache, flushing, sweating, or "goose pimples," and (3) bladder pain with inability to tolerate further filling. These responses are then related to the corresponding bladder volumes. Presence or absence of reflex contractions are similarly noted and the amplitudes recorded. If the patient has neither expelled the catheter nor voided around it after introduction of 400 cc. of fluid, he is asked to strain as in voiding. This final reading is recorded as the maximum voluntary pressure.

Representative cystometrograms are illustrated in figure 3. The atonic bladder in spinal shock is characterized by a low and flat pressure curve, no

reflex contractions, increased bladder capacity, and complete absence of vesical sensations. The automatic reflex bladder usually demonstrates a variable pressure curve, forceful detrusor contractions, no recognition of the normal urge to void, vague sensation of bladder fullness, and, in high lesions, flushing or sweating reaction in the upper part of the body when the bladder reflex is about to act. Patients with an autonomous nonreflex bladder have the following characteristics: increased vesical tone, minor reflex detrusor contractions rarely greater than 10 cm. water pressure, bladder capacity within normal range, lack of definite desire to void, and a feeling of discomfort in the suprapubic area or urethra when the bladder is full.

Cystoscopy. A cystoscopic examination is of value in ruling out the presence of any organic obstructive lesions, such

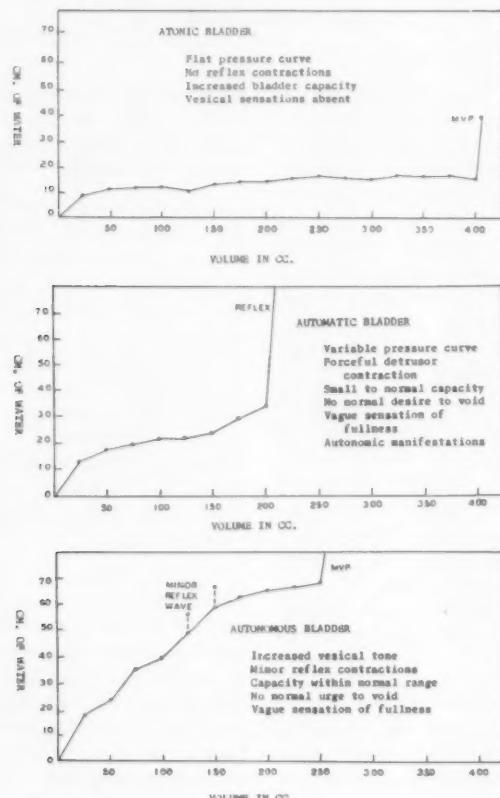


Fig. 3.—Representative cystometrograms in traumatic paraplegia.

as prostatic hypertrophy or urethral stricture, which may contribute to the bladder dysfunction. It is difficult to ascertain the presence of vesical neck contracture or sphincteric spasticity by cystoscopy. Vesical calculi are detected and may be extracted during the examination. An estimate of the degree of bladder infection may also be obtained.

Cystourethrography. A cystogram is taken principally to determine the presence of vesicoureteral reflux. It also discloses changes in the bladder outline, such as trabeculations, saccules, and diverticula. Urethograms reveal the condition of the bladder neck and posterior urethra, as well as the presence of strictures and diverticula in the anterior portion. Spasm of the external sphincter or both urethral sphincters may be demonstrated by cystourethrography and is manifested by closure of the entire length of the posterior urethra and inability to dilate the posterior urethra by injection of radiopaque fluid from the external urinary meatus.

The cystogram is made by introducing approximately 150 cc. of dilute radiopaque dye into the bladder via a catheter. Proportionately lesser amounts of dye are utilized for children. Urethograms are made by gently injecting the contrast medium through the urethra from an Asepto syringe at the external meatus. Anteroposterior and oblique films are obtained in both instances.

Intravenous Pyelography. Intravenous pyelograms provide information on the anatomy of the upper urinary tract and function of the kidney. Back pressure from the bladder is demonstrated by ureteral and renal dilation, both of which are detectable from pyelographic studies. Impairment of kidney function is manifested by a delay in the appearance of the dye and diminished concentration.

Estimation of Residual Urine. Urine left in the bladder after voiding is termed residual urine. The normal bladder empties completely. Presence of residual urine signifies inefficient detrusor action and/or increased resistance at the vesical neck. Residual urine is measured by inserting a urethral catheter after the patient has voided by detrusor reflex

contraction or by abdominal straining and manual compression.

Urinalysis. Microscopic examination of the centrifuged urine sediment under high power provides an approximate indication of the extent of urinary infection. Paraplegics invariably show varying degrees of pyuria, ranging from a few white cells to foul, turbid urine loaded with leucocytes. Bacilluria is similarly a common feature and is always present when a catheter is in place. Urine cultures and antibiotic sensitivity tests are advisable for patients with urinary infection not responding to routine medications.

Treatment

Initial Treatment. A patient with a recent cord injury should be on continuous bladder drainage with a self-retaining Foley catheter (5 cc. bag). It is important that the catheter be no larger than a Fr. 18 because of the danger of urethral fistula from pressure necrosis. In the event of urethral sepsis, drainage can more easily seep out around a small catheter.

The catheter requires careful attention. Syringe irrigation with sterile water or saline should be done daily to insure patency and keep bladder infection minimal. If a tendency to form incrustations in and around the catheter exists, instillation of Solution "G"^{*} into the bladder for a period of 30 minutes during irrigation may help in the dissolution of such concretions. The procedure is done as aseptically as possible and the patient can be taught eventually to irrigate his own bladder. Tidal drainage has been advocated by others but does not appear to have any special advantages. The catheter should be changed every 10 to 14 days even if there is no evidence of incrustations.

Bladder Training. A bladder training program can be instituted while the patient is still in bed as soon as cystometric studies indicate that bladder activity has become reflex in type or vesical tone has been regained. The

*Solution "G": Citric acid powder, U.S.P., 4 oz.; sodium carbonate anhydrous, $\frac{1}{2}$ oz.; magnesium oxide, light powder, U.S.P., $\frac{1}{2}$ oz.; distilled water, q.s. to one gallon. Dissolve in order, add sodium carbonate in small amounts, filter, and sterilize.

catheter is clamped for 1½ hours at a time except at night. At the end of each of these periods, the clamp is released and the patient strains as in normal voiding. The fluid intake is adjusted so that no fluid is taken between 7 p.m. and 7 a.m., and one glass of water (250 cc.) is ingested hourly during the other 12 hours. After the patient is able to remain dry for a week without leakage around the catheter between emptyings, the interval should be increased to 2 hours. After this the interval is increased to 2½ hours, and then 3 hours. Accumulation of more than 400 cc. in the bladder, however, should not be allowed to occur. In the patient with a large urinary output, the period of clamping may consequently have to be shortened.

The catheter may be removed when the patient can stay dry for 3 hours without leaking around the catheter. It is advisable, however, to postpone removal of the catheter until the patient is at least semiambulatory and able to strain more efficiently.

After removal of the catheter, the patient is instructed to void on schedule and regulate fluid intake as before. Urination is usually done in a sitting position. Some patients find that they can empty their bladder best by doing a "push-up," that is, by abdominal straining and suprapubic manual compression. After a time, they may find that they have some trigger area in the abdomen or thigh which, if touched or stroked, precipitates reflex micturition. The patient with a nonreflex bladder obviously cannot develop a conditioned voiding reflex and will have to rely on abdominal straining and Crede pressure to assure effective emptying. Residual urine is checked frequently during the first few weeks after catheter removal.

Some workers report satisfactory control of urination following bladder training in 62 to 78 per cent of their cases.^{2,3} Such patients are able to achieve a system of periodic voiding that keeps them dry and permits an active social life. Our experience has been much less gratifying and a large majority of our patients ultimately

utilize rubber collecting appliances or pads. Nevertheless, we institute bladder training routinely in all our patients as part of their self-care program, except when ureteral reflux is present, because the occasional success makes the effort worthwhile.

High Residual Urine. The amount of residual urine is dependent on a balance between the expulsive forces of urination (detrusor contraction, abdominal straining, and manual compression) and the resistance at the bladder neck. If a high residual urine (more than 100 cc.) is present in spite of efficient expulsive forces, there must be either a mechanical or a spastic obstruction at the vesical neck which should be relieved. However, even if the expulsive forces are weak, satisfactory emptying of the bladder may still be accomplished by diminishing the degree of resistance at the bladder outlet.

Transurethral resection producing a widening of the vesical neck has been of great benefit to many patients with large amounts of residual urine irrespective of bladder type and even in the absence of demonstrable bladder neck obstruction. The procedure, however, is generally not performed earlier than six months after injury. Removal of a ring of tissue or even a small resection of the anterior lip reduces the resistance encountered by the detrusor so that residual urine decreases.

In the patient with an intact sacral reflex arc, a large residual urine may persist in spite of transurethral resections of the bladder neck. Further investigation is then indicated to rule out spastic obstruction by the urethral sphincters. Spasms of the sphincters may sometimes be demonstrated by cystourethographic and sphincterometric studies.

Pudendal neurectomy has been considered as the best treatment for spastic sphincteric obstruction.⁴ The operation appears to be a logical approach to the problem inasmuch as striated muscular fibers innervated by the pudendal nerve are found not only in the external sphincter but also in the vesical neck. Pudendal nerve section should not, however, be resorted to until significant

decreases in residual urine have been demonstrated following local pudendal nerve blocks.

Other procedures such as intrathecal injection of alcohol,⁵ sacral rhizotomy,⁶ and cordectomy⁷ have also been recommended. Some of these procedures, however, have the disadvantage of converting an upper motor to a lower motor neuron lesion and, therefore, abolish reflex detrusor contraction and generally weaken detrusor tone.

Urinary Infection. Some workers in the past have advocated treating the urinary infection in paraplegia only when clinical evidence of sepsis ensued.⁸ Routine medication was not advised because of the fear of drug resistance. Consequently, chronic infection has remained uncontrolled in a large number of paraplegics and probably is the main factor responsible for the observed high incidence of chronic pyelonephritis and renal insufficiency.

With the present availability of a wide variety of broad spectrum antibiotics and other efficacious chemotherapeutic agents, their prolonged administration in reduced dosage is probably advisable in much the same way that similar extended therapy has become acceptable in the treatment of rheumatic infection. We have been prescribing routinely and interchangeably for our paraplegic patients the following drugs for periods of two weeks every month:

1. Methenamine mandelate (Mandelamine), 1 gm. twice daily.
2. Sulfisoxazole (Gantrisin), 1 gm. twice daily.
3. Nitrofurantoin (Furadantin), 50 mg. twice daily.
4. Kynex (Sulfamethoxypyridazine), 250 mg. daily.

The medications are administered continuously whenever a catheter is left inlying. If fever, chills or other evidences of clinical sepsis develop, broad spectrum antibiotics can be given in the usually prescribed dosages. We are presently inclined to believe that chemoprophylaxis should be carried out for the rest of the paraplegic's life.

Calculus Formation. The incidence of calculus formation in the paraplegic

individual is distressingly high, especially during the first two years after injury. As a consequence of lack of stress and strain upon the bony skeleton, large amounts of calcium and phosphorus are liberated from the bones and are swept into the urine where excessive excretions lead to stone formation.

Therapy is aimed to forestall calculus formation by preventing excessive supersaturation of the urine with calcium and phosphorus. It may be accomplished by diluting the concentrations of the implicated crystalloids, by reducing their total excretions, or by increasing their solubilities in the urine.

The concentrations of stone-forming salts in the urine can be reduced most effectively by increasing urinary volume with forced fluids. A paraplegic patient should drink a minimum of 3 liters of water a day.

The excretions of calcium and phosphorus in the urine may be decreased by dietary restrictions and by reduction of bone demineralization. Ingestion of milk and its products should be limited. Absorption of phosphorus from the intestinal tract can be reduced by the oral use of aluminum gels (aluminum hydroxide gel [Amphogel] or aluminum carbonate [Basaljel], 30 cc. four times daily) which convert phosphorus to insoluble aluminum phosphate.⁹ The amount of calcium and phosphorus liberated from bone demineralization can be diminished by changing the position of the bedridden patient several times a day, encouraging bed exercises as soon as the patient is able to do them, using tilt tables and other orthopedic appliances to maintain the patient in an erect position several times a day, and promoting early ambulation.

Various forms of solubilizers have also been advocated. Butt states that a pronounced increase in protective colloids in the urine is produced by subcutaneous injections of 150 to 300 turbidity reducing units of hyaluronidase every 24 to 48 hours.¹⁰ We have not been impressed, however, by our results with this regime. Prien reports that salicylate therapy with 2 gm. of salicylamide in three divided doses daily increases the

urinary glucoronide excretion and thereby increases the solubility of calcium salts in the urine.¹¹ Confirmatory results, however, have not as yet been reported by other workers in this field. Shorr suggests the use of estrogens because an increase in the citric acid excretion results which favors dissolution of urinary calcium precipitates.¹²

If the stone has formed, surgical removal is commonly indicated. Bladder calculi are usually extracted soon after diagnosis. Removal of kidney stones, unless obstructive in nature, is usually deferred until the patient is ambulant because of the high incidence of recurrences during periods of recumbency.

Vesicoureteral Reflux and Hydronephrosis. Vesicoureteral reflux is probably the major factor in the spread of infection to the kidneys among paraplegics. Unless satisfactory bladder drainage can be assured, reflux is also invariably followed by hydronephrosis. The latter, however, can occur with no demonstrable vesicoureteral reflux.

A patient exhibiting vesicoureteral reflux should be carefully observed and intravenous pyelograms and cystograms performed every three months. Bladder training is contraindicated, and at the first evidence of hydronephrosis, a catheter should be inserted and straight bladder drainage instituted. Hydronephrosis with no associated vesicoureteral reflux is also treated by dependent continuous bladder drainage.

Sometimes catheter drainage is not adequate, as evidenced by progressive dilation of the ureter and/or pelvis and calyces. In such instances, suprapubic cystostomy may have to be carried out. Other forms of urinary diversion, recently employed with encouraging results, are transplantation of the ureters to an isolated loop of ileum which is allowed to drain to the outside,¹³ or direct connection of the bladder to a similar ileal segment.¹⁴ Ileal diversion of urine has the advantage of not using infection-laden rubber tubes that act as foreign bodies.

Various workers have described techniques of reimplanting the ureter into the bladder to prevent reflux.¹⁵ These

procedures do nothing to correct the underlying neurovesical disturbance and have not yet been generally accepted.

Hypotonic and Hypertonic Bladder. Parasympathomimetic drugs such as betethenechol (Urecholine) or furtrethonium (Furmethide) (5 to 10 mg. four times daily) are used to stimulate detrusor action in the hypotonic bladder, but are of equivocal value. On the other hand, parasympatholytic drugs such as methantheline (Banthine) (50 mg. four times daily) have been found to be especially useful to relax the hypertonic bladder.

Follow-up Care. The paraplegic patient must be followed with the utmost vigilance for the rest of his life. It should be impressed upon him that his future well-being and chance of survival depend, to a large extent, upon his willingness to cooperate fully in the follow-up examinations. Intravenous pyelography and cystography should be made every year and residual urine measured every six months even when everything appears to be going well. It should also be borne in mind that dangerous renal lesions may develop insidiously and a bladder that empties well is no guarantee for the permanency of good renal function.

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SUCCESS IS THE KEYNOTE

of our Minneapolis — 1959 meeting! An interesting scientific exhibit will contribute much to our success. In addition to the tremendous value of these exhibits, YOU have the opportunity to be considered for one of the coveted awards. Requests for applications for scientific exhibit space in connection with the 37th annual session scheduled for August 30-September 4, 1959, Hotel Leamington, Minneapolis, are now being received. Address all communications to the American Congress of Physical Medicine and Rehabilitation, 30 N. Michigan Ave., Chicago 2, Illinois.

Attention ACPM&R Members —

Suggestions for nomination for fifth vice-president of the American Congress of Physical Medicine and Rehabilitation are now being received by the Nominating Committee. Members in good standing of the ACPM&R may submit their suggestions to the committee. However, when submitting the name of a candidate, a list of the candidate's qualifications for this office should be included. All correspondence pertaining to this announcement should be sent direct to

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A Study of Contractures in Muscular Dystrophy

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● The status of 43 muscular dystrophy patients actively being followed over a three-year period in the Muscular Dystrophy Clinic at University Hospitals of Cleveland has been reviewed. The study reveals certain significant correlations in the functional status and muscle strength with the degree and progression of joint contractures. This study particularly emphasizes the disabling effect of the different types of contractures, particularly in the lower extremities and compares the results of a well-outlined conscientiously applied stretching program with the natural progression of joint contractures in muscular dystrophy. Environmental factors are directly related to the success of a home exercise program. Success in application of lower extremity bracing for advanced dystrophy is dependent on correct timing and shows an important correlation with the extent of contractures. Iliotibial band contracture appears to play an important role in joint contractures and deformity in muscular dystrophy, although little attention has been focused on its role in this disease. The occasional judicious use of surgery in the control of joint contracture and iliobibial band tightness offers promise of an accessory measure in controlling joint deformities.

Functional Classification and Analysis of Data

The patients attending the Muscular Dystrophy Clinic of University Hospitals of Cleveland during the past three years have been classified on a ten-step functional scale. Swinyard, Deaver, and Greenspan's eight-stage classification has been modified by the addition of two functional classes, 3 and 6:¹

1. Walks and climbs stairs without assistance.
2. Walks and climbs stairs with aid of railing.
3. Walks and climbs stairs slowly with aid of railing (over 25 seconds for 8 standard steps).
4. Walks but cannot climb stairs.
5. Walks unassisted but cannot climb stairs or get out of chair.
6. Walks only with assistance or with braces.
7. In wheelchair. Sits erect, can roll chair and perform bed and wheelchair activities of daily living.
8. In wheelchair. Sits erect. Unable to perform bed and chair activities without assistance.
9. In wheelchair. Sits erect only with support. Able to do only minimal activities of daily living.
10. In bed, can do no activities of daily living without assistance.

The measurement of time required to climb eight standard steps has been found to mirror the over-all muscle strength and endurance in Classes 1 through 3. Class 6 has been added between independent ambulation and

wheelchair status for those patients able to walk with braces or other assistance.

The difficulties in definition and interpretation of the term "contracture" have been emphasized by Sandow, Paul, and others.² Physiologically, "contracture" has most frequently been considered the result of prolonged depolarization of the muscle fiber membrane potential. Clinically, muscle or tendon shortening is the most commonly accepted extra-articular cause of the so-called "contracture." Indeed, the mechanisms of contracture development are still as much a mystery in the muscular dystrophies as are most other aspects of these disease processes. We have recorded the limitations of motion without attempting to determine the basic cause. However, since muscle is primarily involved in whatever processes are occurring, we feel that tendon tightness is most likely the result of muscle shortening, the latter being aggravated by prolonged relaxation in a position of flexion or semiflexion. Although the disease process cannot yet be reversed, the progression of deformities can be retarded by counteracting such aggravating positions through appropriate home exercise programs stressing frequent periods of ambulation and stretching areas of tightness.

The number of patients with muscular dystrophy in each classification has been tabulated along with the number and

Read at the Thirty-sixth Annual Session of the American Congress of Physical Medicine and Rehabilitation, Philadelphia, August 26, 1958.

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This study was completed by Dr. Archibald while serving as Senior Instructor of Medicine in Physical Medicine and Rehabilitation, Western Reserve University School of Medicine, Cleveland.

This study was supported in part by funds from the Muscular Dystrophy Association of America.

averages of specific contractures. The number with muscle imbalances around each particular joint is also shown (table 1). As can be seen, almost half (20) the patients fall into either Class 1 or 2. Thirteen patients fall into Classes 3 through 6, and nine are wheelchair patients in Classes 7 through 10. None of the patients presently in wheelchair classes was ambulatory when first attending the clinic, and conversely, none of the patients attending the clinic at reasonable intervals (1 to 3 months) has deteriorated to permanent wheelchair status. No attempt has been made to subdivide the different types of muscular dystrophy in this study. Patients with amyotonia congenita or the myotonias have not been included.

Early Development of Contractures

The development of joint contractures in patients with advanced dystrophy has long been recognized.² Analysis of patients with dystrophy indicates that contractures of joints occur early in the course of progressive muscular dystrophy. Almost all patients in Classes 1 and 2 had already developed tightness or contractures in *all* joints. Indeed, these were usually present when the patients were first seen. The earliest and most severe involvement was found in the gastrocnemius-soleus, hamstrings, and iliotibial band. In the later stages, particularly after a wheelchair status had been reached in Class 7, there was a

marked increase in the severity of the knee, hip, and elbow flexion contractures. Elbow contractures occurred in relatively few patients before progression to Class 6.

As has been pointed out previously, the so-called "heel cord" contractures involve tightness in both gastrocnemius and soleus so that measurement of maximum ankle limitation must be carried out with the knee extended in order to stretch the gastrocnemius with the soleus. Our measurements are in degrees of dorsiflexion deficiency.

Iliotibial Band Tightness

The significance of iliotibial band tightness in muscular dystrophy has received little attention in the literature. In reviewing the anatomy, one finds that the portion of the fascia lata attached to the front part of the iliac crest and corresponding to the origin of the tensor fascia lata, extends down the lateral side of the thigh as two layers, one superficial to and the other beneath the muscle. At the lower end of this muscle, these two layers unite and form a strong band which continues downward under the name of the iliotibial band and is attached to all the lateral prominences just below the knee, including the head of the fibula. Thus, it crosses both the hip and knee joints, where it lies in a plane *anterior* and lateral to the axis of the hip joint but *posterior* and lateral to the axis of the

Table 1: Summary of Joint Contractures in 43 Patients with Muscular Dystrophy

Functional Class	No. Patients	Heel Cord		Knee		Hamstring		I. T. B.*		Hip		Elbow	
		A	B	A	B	A	B	A	B	A	B	A	B
1	8	7	12	5	3	7	32	5	18	4	4	0	0
2	12	11	14	2	1	10	23	11	23	6	10	1	5
3	1	1	10	0	0	1	45	1	20	1	10	0	0
4	3	3	14	1	5	2	25	3	35	3	8	1	23
5	3	3	12	1	10	3	22	2/2	30	1	10	1	10
6	6	6	27	4	5	6	27	4	23	5	21	4	26
7	3	3	33	3	30	3	—	1/1	20	3	19	3	18
8	3	3	50	3	53	3	80	—	—	3	25	2	50
9	3	3	65	3	57	3	—	—	—	3	25	3	35
10	1	1	65	1	50	1	—	—	—	1	30	1	43

A — Number of patients with contracture.

B — Average degree of contracture.

Blank spaces (—) represent patients in whom severity of contracture makes accurate measurement impossible.

*Iliotibial Band

knee joint. Involvement of the muscles attached to this band is responsible for its tightness. These include most of the fibers of the gluteus medius as well as all the fibers of the tensor fascia lata; distally, it gives origin to the short head of the biceps femoris. These deformities, as reviewed by Irwin,³ in poliomyelitis include: (1) flexion and abduction contractures of the hip, (2) contracture of the thigh in external rotation, (3) genu valgum, (4) knee flexion deformity and external torsion of the tibia, (5) varus deformity of the foot, (6) increased lumbar lordosis, and (7) pelvic obliquity. Although the pelvic obliquity probably does not occur as frequently in muscular dystrophy as in poliomyelitis, where the distribution of weakness and tightness is usually more asymmetrical, all the above considerations are nevertheless important in the progression of deformities and contractures.

Iliotibial band tightness is particularly difficult to measure because of problems involved in pelvic stabilization. We have found that the most reproducible, reliable method, in our cases, is to place the patient in a prone position with the hip hyperextended and the knee semiflexed; the pelvis is stabilized as well as possible with the tester's one hand while thigh adduction is attempted, making certain that hip flexion does not occur during the maneuver. Deficiency in thigh adduction from the midline is then determined with a goniometer, as shown in figure 1A.

A better position for stretching, frequently used in poliomyelitis, is the supine position with the hips on the edge of the treatment table and one knee acutely flexed onto the abdomen, as shown in figure 1B. In this position, gravity assists in hyperextending the opposite hip where band stretching is attempted through hip adduction. An alternate method, which may be easier in smaller children, involves the side-lying position with the bottom hip and knee held in flexion to stabilize the pelvis while the top hip is hyperextended before attempting adduction.

The factors involved in tightness of the tensor fascia lata in poliomyelitis

have been outlined by Irwin, Bartenieff and others.^{3,4} These include all muscle weaknesses influencing the relationship of the greater trochanter to the acetabulum and anterior superior spine. Thus, weaknesses in the abdominals, glutei, quadratus lumborum, and iliopsoas, as well as tightness in the hamstrings, hip adductors, quadratus lumborum, and internal obliques, contribute to the progression of deformities. Of these muscles, the glutei and abdominals seem to show the most prominent early weaknesses in muscular dystrophy. Thus, hip extensor weakness immediately permits the tensor fascia lata to pass further anterior to the greater trochanter and is therefore probably one of the most significant early causes of iliotibial band contracture in this disease.

Muscle Imbalance

Agonist-antagonist muscle imbalances of at least one full grade are tabulated in table 2. In all classes, except 6, there are muscle imbalances across each individual joint in from 50 to 100 per cent of the cases. There is a lower incidence of muscle imbalance about the elbow in the better functional classes. This is reflected in decreased contractures in this joint early in dystrophy. In advanced dystrophy

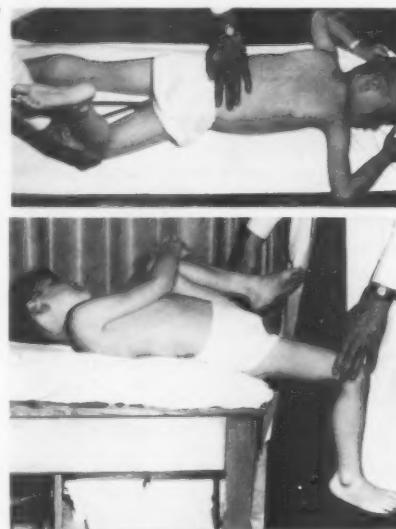


Fig. 1 — A (left), method of testing iliotibial band in prone position; B (right), method of stretching iliotibial band in supine position.

Table 2: Summary of Agonist-Antagonist Muscle Imbalance in 43 Patients with Muscular Dystrophy

Functional Class	No. Patients	Ankle Dorsiflexors vs. Plantar Flexors	Knee Extensors vs. Knee Flexors	Hip Adductors vs. Hip Abductors	Hip Extensors vs. Hip Flexors	Elbow Extensors vs. Elbow Flexors
1	8	4	3	4	6	2
2	12	8	8	7	7	3
3	1	0	1	0	1	1
4	3	2	1	1	0	1
5	3	0	3	3	2	1
6	6	3	5	1	3	2
7	3	2	3	2	2	2
8	3	—	—	—	—	2
9	3	2	3	2	2	2
10	1	1	1	—	1	1

Blank spaces (—) represent patients in whom severity of contracture makes accurate measurement impossible.

(Classes 7 through 10) the majority of patients have muscle imbalance and joint contracture about the elbow. It is difficult to assess muscle imbalance in far advanced states because of generalized atrophy due to both disease and disuse factors aggravated by wheelchair confinement. At this stage, both agonists and antagonists became "Poor" to "Zero." Although many of the specific contractures are accompanied by corresponding muscle imbalances, it should be emphasized that tightness and joint contractures can be aggravated if not initiated by muscle imbalances occurring across other more distant joints. For example, all three patients in Class 5 had significant heel cord tightness, but the gastrocnemius and anterior tibial muscles were equally graded in all three cases; undoubtedly, the muscle imbalance around the hips and knees contributed to the development of significant heel cord contractures in these cases. It readily becomes apparent that a multiplicity of weaknesses and imbalances initiates a vicious cycle leading to contractures, more imbalance, followed by more tightness, contractures, asymmetry, and deformity as shown in figure 2.

Inasmuch as muscle imbalance is probably just as important as specific muscle weakness, exercise programs should be directed toward strengthening the extensor muscles listed in the left

column of table 3, plus stretching the flexor antagonists listed in the right column. An exception is hip abduction where it is important to strengthen the gluteus medius in its prime movement of abducting the *extended* hip; the tensor fascia lata, on the other hand, tends to flex the hip during abduction. Thus, the hip adductors and tensor should be opposed by as strong a gluteus medius and maximus as possible in order to retard the development of iliotibial band tightness. Kaplan⁵ has recently pointed out that so-called iliotibial band "contracture" is probably due to involvement of the gluteus medius and minimus more than the tensor fascia lata; con-

Table 3: Agonist-Antagonist Muscle Imbalance in Muscular Dystrophy

Physical Therapy Program

PRE for Muscles > F+	Range of Motion and Stretching
Muscle Groups	
Agonist	Antagonist
Elbow extensors	Elbow flexors
Hip extensors	Hip flexors
Gluteus medius	Tensor fascia lata
Hip internal rotators	Hip external rotators
Knee extensors	Knee flexors
Foot dorsiflexors and evertors	Foot plantar flexors and invertors
Trunk flexors	Trunk extensors



Fig. 2 — Pernicious cycle of progressive deterioration in muscular dystrophy.

tractions of these muscles plus the vastus lateralis result in progressive iliotibial band tightness.

We have concentrated our efforts on the muscle groups listed in table 3, because of their obvious functional significance, the emphasis depending on the patient's functional status.

Iliotibial Band's Role in Lordosis

Heretofore, the development of severe lordosis in muscular dystrophy has been blamed primarily on muscle weakness. Another factor which has been implicated is muscle imbalance between weak anterior abdominals and relatively stronger trunk extensors. This imbalance produces a compensating lordosis as the patient attempts to keep the line of gravity sufficiently posterior to the hip joints to prevent buckling at the hips. The early increase in hip extensor weakness also makes such a position progressively more necessary for stability in standing and walking. Although these muscle imbalances and weaknesses undoubtedly contribute to the lordosis, other factors must also be considered, including the increased pelvic tilt produced by a tight iliotibial band. It is difficult to determine how much each factor contributes to the development of this increasing lordosis, but it appears that all these factors are

interrelated in a complex pattern of checks and balances. The iliotibial band tightness undoubtedly plays a greater role than previously recognized.

It is interesting to note that lumbar lordosis in muscular dystrophy has been decreased following a Yount iliotibial fasciotomy.⁶ This occurred without any change in the abdominal muscle strength. The patients were able to walk more easily with a narrower based gait. A postoperative stretching program, however, must be followed conscientiously, since the muscle imbalance is unchanged by the operation. If postoperative stretching is not continued, iliotibial band tightness returns, lordosis again becomes severe, walking is more difficult, and the patient must resume a broader based gait.

Maintenance of Ambulation and Activity Prior to Bracing

As can be seen in table 4, there appears to be a direct correlation between the ability and willingness of patient and family to cooperate in the conscientious pursuit of a home exercise program and the maintenance of a good functional status. A well-outlined home physical therapy program is more likely to be followed during the early stages of the disease. Later, as might be expected, the

patients and parents become frustrated and discouraged by progressive deterioration and exhibit less motivation and cooperation in such a program.

As the time spent in standing and walking decreases, the concomitant increase in sitting time contributes to further disuse weakness, muscle imbalance, tightness, and joint contractures. The vicious cycle is perpetuated and becomes increasingly difficult to reverse. Continued weight bearing favoring one side of the body contributes to further muscle imbalance and development of asymmetrical contractures. It would seem wise to concentrate efforts and resources on the earlier stages where patients can receive maximum "prophylactic" benefit and where cooperation is easier to obtain.

Night Splints

Night splints of the long leg variety are not tolerated by most patients. It has made no difference whether these are long leg night splints, casts, or braces. Short leg braces, used as night splints alone, may help retard the progression of ankle contractures, but they achieve better results when combined with an appropriate stretching program. Splinting certainly should not serve as a substitute for manual stretching. For example, one patient developed increased ankle tightness when stretching was neglected after application of night splints; this was reversed when manual stretching was resumed. Short leg night splints can initiate or increase knee flexion contractures due to the added tendency of patients to flex their knees in order to relieve discomfort from gastrocnemius tightness. They certainly are of no value in later stages of the disease when equinovarus deformities of the ankles have developed.

Bracing

Proper bracing plays an important role in retarding the development of contractures and progression to a wheelchair status. Correct timing is essential for successful bracing in muscular dystrophy. This necessitates regularly scheduled follow-up visits at fairly frequent intervals and instructing the parents to commun-

Table 4: Relationship of Functional Class and Family Cooperation in a Muscular Dystrophy Physical Therapy Program

Functional Class	Family Cooperation*
1	3+
2	3+
3	4+
4	2+
5	1+
6	2+
7	1+
8	0
9	0
10	0

*Averages of individual family cooperation estimated by the clinic staff. Based on 0 to 4+ rating.

icate immediately any deterioration in the child's ambulation status. Bracing cannot be prescribed too early in the disease if one hopes to gain patient acceptance. Conversely, it is essential that bilateral long leg braces be fitted before contractures become too advanced. Long leg braces are ordered at the time when the child cannot ambulate independently without external assistance either from parents or by holding on to furniture. At this time, the patient must actively contract his gastro-soleus in order to extend his knees. By so doing, the heels fail to touch the ground during ordinary standing or walking. Also, the quadriceps test less than "Fair" and the patient's functional status has deteriorated to Stage 4 or 5. If standing and walking are permitted in this manner, heel cord tightness rapidly increases. Long leg braces with 90-degree ankle stops and ring locks at the knees should be prescribed at this stage so the patient will not have to depend on active contraction of his gastrocnemii for walking. The braces also retard the development of heel cord contractures and equinovarus deformities of the feet while supporting the knees in extension. However, if tibial torsion secondary to tight iliotibial bands is present, bracing may aggravate these deformities unless the thigh portion of the brace is rotated externally to compensate for the torsion. Correct bracing at this time does not hinder, but rather assists balance and walking, despite severe hip extensor

weakness which is usually present. Although ambulation is frequently slow, it is more stable.

Our experience with pelvic bands has been limited, since patients in braces have done better without them. This additional bracing tends to throw the line of gravity too far forward. Also, a pelvic band tends further to limit hip motion, making walking more difficult. Bracing with a pelvic band and Knight spinal attachment has been used by others in more severely involved patients. In these cases, although standing is feasible, walking is extremely difficult if not impossible. Homemade tilt tables have occasionally been used for these more severely involved patients.

Progression to Permanent Wheelchair Status

No patient regularly attending the clinic during the past three years at reasonable intervals of one to three months has deteriorated from an ambulatory to a wheelchair status. Except for two patients who went from Class 2 to Class 6, no other patients deteriorated more than two classes over the past three year period. In at least two cases, complicated psychological problems in the family interfered with their ability to cooperate in following home exercise programs.

A wheelchair status lasting over six weeks is difficult if not impossible to reverse satisfactorily, no matter what the cause. The loss of independent ambulation for periods up to two weeks has been successfully reversed on several occasions by appropriate intensive physical therapy and bracing procedures. Wheelchair confinement is premature in some instances. This is due mainly to psychological factors. For example, one patient who was ambulating independently suddenly stopped walking on his eleventh birthday, which was coincidentally the anniversary of his brother's death from muscular dystrophy. In other cases, non-muscular illness or involuntary wheelchair status was instrumental in the deterioration. No patients in wheelchairs for more than six weeks were reversed to a standing or ambulatory status. Their

contractures were too severe to permit bracing without intensive surgery and plaster cast applications, the latter necessitating prolonged immobilization with progression of disuse atrophy. In some of these patients, homemade tilt tables have been used to keep them upright.

Surgery

In a few selected patients with iliotibial band "contracture" but with little or no heel cord tightness, bilateral Yount fasciotomies were performed. Ambulation and iliotibial band stretching were resumed one to two days postoperatively. All of these patients demonstrated at least temporarily improved walking ability with less lordosis and a narrower based gait. One patient whose parents did not continue stretching postoperatively again developed iliotibial band tightness along with increased heel cord contractures, necessitating repeat Yount fasciotomies along with bilateral heel cord lengthenings before long leg bracing. No fasciotomy other than the Yount type has been performed thus far.

Heel cord lengthening as a definitive isolated procedure cannot be successful with a weak quadriceps unless bilateral long leg bracing has already been planned. It can, however, permit better balance in walking for patients with long leg braces. Iliotibial band sectioning, on the other hand, can delay bracing and can improve balance and walking before and after bracing. The surgical management of contractures reported here represents only a preliminary exploration of the subject.

Summary

The status of 43 muscular dystrophy patients seen during the past three years in the Muscular Dystrophy Clinic of University Hospitals of Cleveland has been reviewed. This study reveals certain significant correlations in functional status and muscle strength with degree and progression of joint contractures. It emphasizes the effect of different types of contractures on the lower extremity. A well-outlined, conscientiously applied exercise and stretching program effec-

tively retards the natural progression of joint contractures in muscular dystrophy when started early in the course of the disease. Environmental factors are directly related to the success of a home program.

Iliotibial band contractures appear to have an important influence on joint contractures and deformities although little attention has been focused on their role in this disease. Bracing in progressive muscular dystrophy patients has been shown to retard deterioration to a wheelchair status. It also appears to be helpful in retarding the development of contractures. The occasional judicious use of surgery may be justified as a possible adjunct.

The present management of muscular dystrophy is frequently discouraging, frustrating, and unsatisfactory. Nevertheless, every attempt should be made to retard the natural course of the disease by the early initiation of an appropriate program. This present report emphasizes some of the unsolved problems and

underlines the need for a continued energetic analysis of methods to control the progression of this baffling disease.

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DEDICATION SERVICES

Formal dedication of the Gertrude Beard Physical Therapy Laboratory was held on Sunday, March 15, at Northwestern University Medical School, Chicago. Two bronze plaques were unveiled honoring the late Dr. John S. Coulter, first medical director of the course in physical therapy, and Gertrude Beard, first director of the course. The plaques were unveiled by Mrs. Coulter and Miss Beard. Dr. Coulter was a pioneer in this specialty. He established the program at Northwestern in 1927, now one of the oldest continuing programs in the country.

Effects of Ultrasound on Growing Bone

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● The epiphyseal area of growing bone is currently considered a contraindicated site for ultrasonic therapy. Previous studies show that damage occurs to bone cortex and bone marrow with high intensities of ultrasound. The effect of clinical doses of ultrasound upon the epiphyses of growing rabbits was studied. The left knee area of 20 animals was treated underwater with 1 w/cm² from a 12 cm² sound head for five minutes daily from the age of three months until there was x-ray evidence of epiphyseal closure (6-8 months). The untreated legs served as controls. Comparison of the data showed no significant difference in bone length, microscopic appearance or rate or manner of epiphyseal closure between the treated and control leg.

The pronounced effects of large amounts of ultrasonic energy upon mature and growing bone have been well documented by many independent investigators. In 1948, Buchtala¹ treated very young dogs four to six times with moderate intensities of ultrasound and reported marked destruction about the epiphyseal area, with cessation of bone growth, when the transducer was held stationary. With a moving transducer, similar intensities of ultrasound caused periosteal and epiphyseal stimulation with an increase in the size of the ossification center. It was suggested that bone length might be retarded or stimulated at will by altering the ultrasound intensity and application.

While studying the effect of ultrasound on adult bone, several other authors²⁻⁴ have described increased osteogenesis with doses below the destructive level. De Forest and co-workers⁵ in 1951 applied ultrasound to immature epiphyses in three different doses and observed destructive changes with all three, accompanied by cessation of long-bone growth. These changes were intensified with the higher doses but occurred to some degree at all dosage levels used.

Since these abnormalities have been produced, particularly in the epiphyseal area, by exposure to ultrasound, clinical application of ultrasound to growing bones has been considered contraindicated. Many of the experiments on which this conclusion is based utilized techniques that held the treated part continually within the ultrasonic field. The usual clinical application, however, involves constant localized movement of

the transducer to prevent abrupt temperature rises (and often includes a longer series of applications).

To clarify the effect of clinical doses of ultrasound upon the epiphyseal area of growing bone, we attempted in this study to simulate a clinical technic, whereby the transducer is moved over the part to be treated.

Method and Materials

The ultrasonic generator used in this study (Dallons Medi-Sonar) has a frequency of 1 megacycle; the transducer has a quartz crystal with an area of 12 sq. cm. The total output of ultrasonic energy was measured by a sound pressure meter (Dallons Sonotest) before and after each day's use. A special device (fig. 1 and 2) was made to insure uniform rhythmical excursions of the transducer, which was directed so as to expose the left upper tibia of the rabbit to the ultrasound. The transducer was inserted in a clamp which was driven back and forth along a track by a small electric motor. The mid-point of the crystal face moved through a stroke length of 9 inches, at a rate of 18 strokes per minute, and the radiating surface itself was 3 inches from the lateral surface of the left knee. Both the transducer and the rabbit's left hind leg were immersed in water degassed by boiling and kept at a temperature of 36 C. with a thermostatic heater. A small air-driven stirrer was used to insure uniform water temperature throughout the tank. The rabbit's left hind leg was held in position under water by a strap around the foot;

Read at the Thirty-sixth Annual Session of the American Congress of Physical Medicine and Rehabilitation, Philadelphia, August 26, 1958.

Instructor, Physical Medicine and Rehabilitation, University of Michigan School of Medicine; formerly, Fellow of the National Foundation for Infantile Paralysis, Inc., now, The National Foundation.

Associate Professor of Physical Medicine and Rehabilitation, University of Michigan School of Medicine and University Hospital.

This study was supported in part by the Gertrude Durham Kirkpatrick Memorial Fund, University of Michigan School of Medicine, Ann Arbor, Mich.

the strap was of nylon lined with sponge rubber.

In order to eliminate an air barrier between the water and the animals' skin, the left hind leg of each rabbit was freed of hair with a chemical depilatory* and a small amount of detergent solution was added to the water.

A series of 20 rabbits of the same age was treated with 1 watt per square centimeter (12 total watts) for 5 minutes daily, 5 days a week, from age 3 months until x-ray evidence of epiphyseal closure was obtained. This dose did not cause pain. Baseline x-rays were taken of both the left (treated) and right (control) hind legs before treatment was begun (at age 3 months), and, beginning at age 5 months, weekly x-rays were made until evidence of epiphyseal closure appeared. When closure of the epiphysis had occurred in all 20 animals, they were sacrificed and the lengths of the disarticulated tibiae and humeri were measured. The tibiae were then split and

fixed in formalin, and microscopic slides were made of the decalcified material.

Results

The results are summarized in figure 3. These 20 rabbits, all approximately 3 months of age at the onset of the study, showed x-ray evidence of epiphyseal closure following 10 to 18 weeks of treatment. In 7 of the 20 (Nos. 41, 45, 54, 57, 59, 60, 61) there was a difference between closure times in the treated and the control upper tibial epiphysis; however, in 3 of the 7, the treated epiphysis closed first (Nos. 41, 45, 61) and in the other 4, the control epiphysis closed first (Nos. 54, 57, 59, 60). The difference in closure time was one week in 5 of the 7 animals, and two weeks in the remainder.

To determine the individual variation between the right and left extremities, the right and left humeri were measured, revealing an average difference of 0.2 mm.

The average difference in length between the treated and control tibiae was 0.6 mm., varying from 0 to 2.5 mm. In only 5 of the animals was there a difference greater than 1 mm. (Nos. 41, 47, 48, 56, 60). In 2 of these 5 animals (Nos. 47, 56), the control tibia was the longer, and in 3 (Nos. 41, 48, 60) the treated tibia was the longer. It should be mentioned that the rabbit in which the greatest difference (between treated and control tibiae) was noted had been sick during the middle of the study, and this may have influenced growth. The difference in leg length was tested by the statistical technic of the standard difference between the means. The associated probability was .92, indicating that the variation in leg length is probably due to chance.

Histologic examination of the upper epiphyseal areas of the left and right tibiae revealed minimal periosteal thickening and fibrosis with scattered foci of subperiosteal new bone formation. These changes were minimal and occurred to a similar degree in both the treated and control legs, with the exception of 4 animals in which the control section was



Fig. 1 — Apparatus designed to produce uniform rhythmical excursions of the transducer under water.

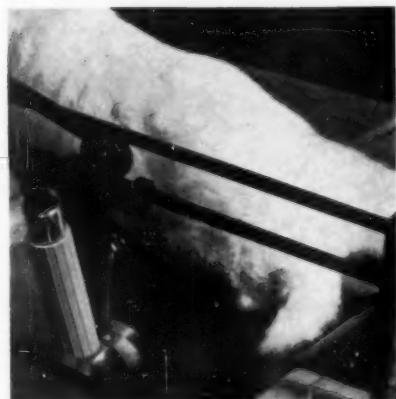


Fig. 2 — An unanesthetized rabbit held in position by straps with the left knee area immersed directly in the path of the ultrasonic energy from the moving transducer.

*Purified yellow barium sulfide, 20 gm.; wetting agent (Duponol C), 15 gm.; glycerin (10 per cent aqueous solution), 50 cc.

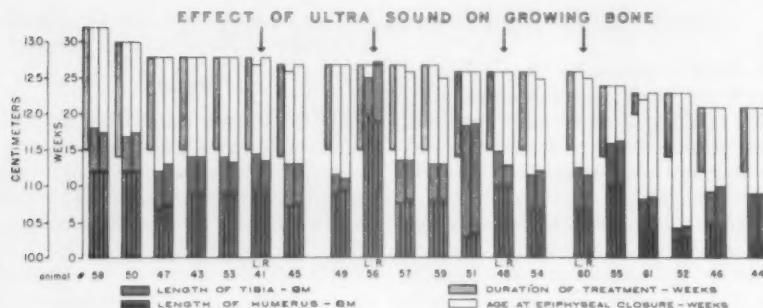


Fig. 3 — Comparison of the left (treated) and right (control) hind legs of the 20 rabbits with respect to tibial length, humeral length, duration of ultrasound treatment, and closure time of the upper tibial epiphyses. The left upper tibial epiphysis of each rabbit was treated daily for 5 minutes with 1 watt per square centimeter of ultrasound (12 total watts). The arrows indicate those animals in which the difference in leg length was greater than 1 mm.

reported as entirely negative. Our pathologists considered all these changes to be within normal limits for rabbits of this age.

Summary and Conclusions

Twenty rabbits were treated daily with 1 watt per square centimeter of ultrasound to the left upper tibial epiphyseal area, from age 3 months until x-ray evidence of epiphyseal closure was obtained (6-8 months of age). The animals were then sacrificed, the tibial and humeral bone length measured, and histologic examination performed on material from the epiphyseal area.

From this study we may conclude that, in rabbits, ultrasound applied in this dosage and in this manner has no significant effect on bone length, epiphyseal integrity, or closure time.

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The 36th Annual Conference of the American Physical Therapy Association will be held at the Hotel Leamington in Minneapolis, June 21-26, 1959. The scientific program is centered around the subject of Pain. The neuro-anatomical and neurophysiological relationships of pain will be discussed. Physicians and Physical Therapists will participate in a 4-day presentation of this important subject.

Role of the Work Classification Unit of the Los Angeles County Heart Association

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• The Los Angeles County Heart Association work classification unit has been in operation for almost four years. In that period it has successfully shown to employers, personal and industrial physicians, and others that many patients with cardiovascular disease are capable of working. Two important conclusions have resulted from this experience. One is that a demonstration of workability is not the same as a demonstration that heart patients can be rehabilitated. Actually, the demonstration of workability becomes the justification for rehabilitation services. The second is that demonstration does not mean simply "showing" that many heart patients can work. It must also mean changing community attitudes and patterns of service. This necessitates such activities as publicity, training, observation, and extension of services. This concept also has implications for the length of time required for a successful demonstration.

Misconceptions about the work ability of individuals with heart disease have resulted in a significant problem of "cardiac unemployment." Such misconceptions and resulting poor judgments arise from ignorance, personal bias, and incomplete information. This is surprising in view of increasing evidence that many patients with heart disease can work at a normal or near-normal work load.

This contradiction between what the patient with cardiovascular disease can actually do and what he is usually allowed to do is a serious concern of the American Heart Association and other health and rehabilitation organizations. Many local heart associations have attempted to meet this problem through the establishment of work classification units. One of these projects is the unit of the Los Angeles County Heart Association, now in its fourth year of operation.

During this time, considerable experience has been accumulated with regard to "cardiac unemployment." It now seems timely to collate this experience in order to: (1) evaluate the effectiveness of this unit in the past and (2) clarify its role in the future. Such an analysis may be of interest to others who are dealing with the same problems.

The Los Angeles unit was set up to demonstrate in this community that

many heart patients could work if properly evaluated. As originally conceived, two main factors were necessary to accomplish this objective. First, it was necessary to provide a service which could evaluate the safe work level of patients in relation to the energy requirements of a specific job. Second, it was necessary to test judgments of work ability on actual jobs. In other words, it would only be possible to demonstrate work ability of heart patients if the unit could examine patients, make specific work recommendations, and then at a suitable interval test such recommendations by observation of the effects on patients.

The need for an actual test situation provided by a job could have been met in two ways: (1) It would have been possible to attempt placement of patients on jobs after evaluating their work ability. This approach would require any or all of the services of a total rehabilitation program, including diagnosis, treatment, job counseling, training, and placement. (2) It was possible to avoid the necessity for developing such a broad range of services by selecting patients who were already working or had jobs to which they could return. Such a limitation in no way sacrificed the essential purpose of this demonstration. On the contrary, it made possible a clearer demonstration which avoided many complicating and uncontrollable variables.

This latter approach also led to the significant insight (for us) that a demonstration that heart patients can work is not the same as a demonstration that heart patients can be rehabilitated. Rehabilitation is a much broader concept and includes the assumption that heart patients can work. Actually, the public

assumes the contrary—that heart patients cannot work. Hence, the demonstration which corrects this misconception goes literally to the heart of the matter. There needs to be a fundamental change in attitude in regard to work ability. This would eliminate the most serious obstacle to effective rehabilitation of individuals with heart disease.

Patient Procedure

The implications of this approach can best be illustrated by following a patient through the work classification unit.

Mr. P. sent a letter to the unit in which he explained that he was a school-teacher who had lost a job following a heart attack from which he had recovered. It was ironic that the attack had preceded his gaining tenure by just one week. He made a barbed comment about the President who had retained his job under similar circumstances. Mr. P. felt his own teaching responsibilities were not quite as heavy!

A telephone conversation by the social worker with the patient revealed he was currently working on two part-time teaching jobs in different school systems and that he had a third part-time job doing heavy work as a carpenter. The patient was asked to discuss referral to the unit with his personal physician. Later the personal physician called to make the referral on the basis of the need for an evaluation of the patient's ability to carry his current work load. The medical history was routine—a myocardial infarction followed by an excellent recovery.

The school physician was called, with the consent of the patient. School board policy, based on concern about insurance rates and the danger of recruiting a high percentage of employees with heart trouble if physical standards were lower in this school system than in others, was responsible for the patient's loss of employment. (The doctor was invited to visit the unit in order to observe the operation and discuss the questions he had raised.)

Only after these preliminary contacts was an appointment made. Material explaining the unit was mailed to the

patient, school, and personal physician. The patient was asked to complete a questionnaire about his work load, work history, and related social and economic problems. The doctors were asked for medical information, electrocardiograms, chest films, and a job description.

On the day of the examination, Mr. P. was relieved to know that the entire procedure would be completed in one session. (The unit meets one day each week, processing two new patients and two rechecks.) It meant less time lost for him. (Probably, it meant less anxiety, too, and certainly more efficient operation for the staff.) The social worker explained the day's procedure so that Mr. P. knew what to expect. He was told that we were attempting to answer one question, namely, how safe was it for him to work in his present and previous job arrangements.

In the hospital laboratory, routine blood and urine tests were completed. In an interview the unit social worker obtained a detailed picture of the energy requirements of Mr. P.'s part-time jobs as well as of his extracurricular activities. Essentially, Mr. P. was a well-adjusted individual who took a realistic view of his problem. He had a wife and three children and financial needs were pressing. The unit cardiologist reviewed material received from the personal and school physicians, took a medical history, and completed a detailed physical examination. The result was a diagnosis of a healed myocardial infarction.

In the special physiological lab Mr. P. took pulmonary function tests, a resting electrocardiogram, and a standardized walk on the treadmill for 10 minutes while pulse rate and respiratory and electrocardiographic data were recorded. This stress testing, with equipment not usually available, gave a picture of an essentially normal heart and lung response while resting, working, and during the recovery period.

At the staff conference which followed, the cardiologist, physiological technician, and social worker each presented his independent findings. Present were several visitors, one physician, and one personnel man from a large industry, who had been

invited to observe the unit operation. The regular staff and several trainees (cardiology fellows) discussed the findings and arrived at recommendations.

The patient was called in and the physician explained the unit recommendations. He was told that he could do his regular job as a teacher without difficulty and that he was also capable of doing his present three part-time jobs. He was told that both physicians would be advised of his recommendations. The patient, of course, was very pleased. One question about diet was referred back to the personal physician. (Referrals for rehabilitation, employment, or other services are discussed with the patient at this time, if necessary. The impact of this procedure on patients has been great. Many have said that the visit to the unit was the turning point in their illness. They felt that recommendations were based on a real understanding of their case and they were especially pleased by the opportunity to ask questions about the recommendations.)

The following day a telephone report was made to both physicians in the case. This was followed by a detailed written report approximately 10 days later. This report by the unit physician included copies of physiological test data.

Six months later the patient was scheduled for a recheck visit. It was determined that he had continued to function well on his part-time jobs.

There was an additional hoped-for, but somewhat unexpected outcome. Apparently, the school physician had felt sufficient reassurance as a result of the unit study to attempt successfully to reverse the previous medical decision. The patient was to be considered for employment in the school system at the beginning of the coming school year.

The above case presentation clearly illustrates the method and possible result of the demonstration. The unit estimated the patient's ability to meet the energy requirements of a specific job. Working on the job, the patient demonstrated his ability to do this work successfully. By involving the school physician in this demonstration and reporting back to him, it was possible to

modify the policy of an administration responsible for the hiring of thousands of employees. The possibility of a change in attitude in the future with respect to other patients with cardiovascular disease seems greater as a result of this single demonstration.

Many employers in the Los Angeles area have witnessed numerous examples of the work ability of their employees with heart disease. A successful experience with such an employee makes employers more responsive to the employment of other individuals with cardiovascular disease. Beyond the psychological impact on employers there is another organizational effect. Hiring one employee with heart disease results in administrative precedents that make it easier for similar future hirings.

Other Activities

As part of a demonstration that individuals with heart disease can work, other activities have been added to the operation of the unit.

Training. From the beginnings of the unit it was clear that in order to correct erroneous opinions about the ability of heart patients to work, physicians also needed to know of the operation and experience of the unit. In other words, physicians had to be included in the demonstration. Hence, there has been a training program for cardiology fellows almost since the inception of the unit's operation. Subsequently, one or two former physician-trainees have joined the regular staff for extended periods of time. Experience in the work classification unit is to be included in at least one of the residency training programs in cardiology in this area.

Observers. Visitors to this unit have been encouraged. Industrial and private physicians, personnel managers, executives, and lay and professional individuals interested in heart disease and rehabilitation have been included. It has been the practice to extend an invitation to observe the unit's operation to every physician making a referral.

Publicity. Reports and summaries of the unit's work have been mailed to key individuals in this community. The work

of the unit has been the subject of several press conferences. Letters have been mailed to special groups, and brochures about the work classification unit have been used as part of the Heart Association's fund raising campaign.

Professional Activities. Initial presentations about the unit were made to the industrial section of the Los Angeles County Medical Association, the Greater Los Angeles Welfare Council, Personnel Manager's Association, and other community groups. The unit's staff will participate in a program to be sponsored by the Heart Association and the local chapter of the National Rehabilitation Association which will involve discussion of the problems of rehabilitation of the heart patient. It is hoped that similar activities can be extended to include other organizations.

It is inevitable that an evaluation of these activities must lead to an examination of what is meant by the term "demonstration." Clearly this term means more than offering a service to a small group of patients. It seems important to involve in some way as many people as possible in the work of the unit. The purpose of this is to modify the attitudes of the community with the end in view of achieving a different pattern of services for the patient with heart disease who needs to work. Thus, a second significant insight has evolved from the operation of the unit. The demonstration is not simply to show that many heart patients can work but also to change community attitudes and patterns of service for this group of individuals.

In the initial phase or demonstration of the work of the unit it is necessary to develop a clear-cut way of providing service. This involves solving problems related to (1) the type of service, staff, source of referrals, referral procedure, reporting and (2) the best method of estimating work ability.

In the next phase, the "community organization" type of activity directed at "spreading the word," and changing community attitudes, represents not so much a difference in kinds of activities as a different emphasis. An organized

publicity program, a training program for physicians and other interested disciplines, a program of observation of the unit by many individuals in the community, participation by the staff in professional activities in the community, systematic contact with other health and rehabilitation services — all of these need more stress. Ways and means need to be found for including the patient services of the unit in other existing community agencies.

Our experiences allow other conclusions to be drawn. The "service" aspect of the program needs to be maintained only at that level which will provide sufficient material for the accomplishment of these second phase objectives. The patient load is not correlated with the extent of the problem in the community. It also becomes clear that one must regard this as a long-term project. An effective change in community attitude is necessarily the result of many years' work.

And, finally, without the "demonstration" purpose, there could be little reason for setting up a segment of service under independent auspices. Actually, as a demonstration, this independent sponsorship makes for a more dramatic and flexible use of the unit.

Criteria of Eligibility

The criteria of eligibility have become more precise as a result of the unit's experience.

1. Referral must come from an industrial or personal physician.
2. If the referral is from the industrial physician, then the personal physician must concur in the referral.
3. If the referral is from the personal physician, then the patient and doctor must give their consent for the unit to secure either medical or job information from the industrial physician or personnel manager.
4. There must be an existing diagnosis of heart disease.
5. There must be a problem of work level, that is, an existing job and a question of the patient's ability to perform his work.

6. The patient must be willing to undertake the examination.

Staff

One of the important aspects of the work of the unit is the team approach. The contributions of representatives of several professions enrich the work. But this does not happen unless there is a clear definition of responsibilities and an opportunity for the free interchange of opinions which lead to common recommendations about patients.

The concept of the function of the unit dictates the staff required. It has been necessary to have available the skills of the cardiologist, the physiological technician, and the social worker. Were the unit to offer other rehabilitation services, it would be necessary to have the additional skills of other professions, such as the vocational counselor, psychologist and psychiatrist.

Summary of Unit's Operation

In 93 per cent of the cases (133) seen in the first 26 months of the unit's operation, recommendations were made for full work or for work with some limitations. Only 7 per cent of the patients referred were regarded as too ill to work. In no case was it necessary at the time of recheck, some 6 to 12 months later, to make more restrictive recommendations. (Approximately one third of the original group had been seen for two or more visits.)

Some 54 different companies were represented by the patients seen in the unit. To many of these employers there was an effective demonstration that an employee with heart disease could work. Personnel policy of large organizations has been modified in a number of documented instances and the continued employment of individuals with known heart disease has been made possible in many cases through the activities of the work classification unit.

A number of unsolicited compliments have been received regarding the thor-

oughness of the study of patients, the objectivity of recommendations, and, perhaps most important, on the strengthening of relationships between patients and their private physicians.

This experience has proved that many patients with heart disease are able to work successfully. It has confirmed that such a demonstration is possible through the use of patients who are working or have jobs to which they may return.

Summary and Conclusion

The Los Angeles County Heart Association work classification unit has been in operation for almost four years. In that period it has successfully shown to employers, personal and industrial physicians, and others that many patients with cardiovascular disease are capable of working.

Several significant "insights" have resulted from this experience. One is that a demonstration of work ability is not the same as a demonstration that heart patients can be rehabilitated. Actually, the demonstration of work ability becomes the justification for rehabilitation services.

The second is that demonstration does not mean simply "showing" that many heart patients can work. It must also mean changing community attitudes and patterns of service. This necessitates such activities as publicity, training, observation, and extension of services. This concept also has implications for the length of time required for a successful demonstration.

It is clear that the unit has a continuing function, which will require a number of years to achieve — to change the popular misconception that heart patients are unable to work.

This analysis, if correct, has many implications for the future of the work classification unit of the Los Angeles County Heart Association. These conclusions should also be of interest to others who are dealing with the same problems.

"L'Etoile du Nord"

portrait of minnesota. ii

"Land of sky blue waters" about which poets have written for a century or more is a name derived from two Sioux Indian words. "Minne" means water, and "sota" has been translated as clear and sky-tinted. Sky-tinted water is the translation most widely accepted.

It is true — Minneapolis is a beautiful city with its gleaming skyscrapers, its modern mills, its magnificent residences and its spacious parks. It is a sparkling gem in the "land of sky blue waters" — a gateway to Minnesota's superb vacationland. It is the largest metropolis in the upper midwest, and is often called "Hub of the Upper Midwest." It provides an abundance of cultural, recreational, industrial and commercial facilities. Situated as it is on the 45th parallel, midway between the equator and the north pole, Minneapolis' climate is pleasingly mild in summer.

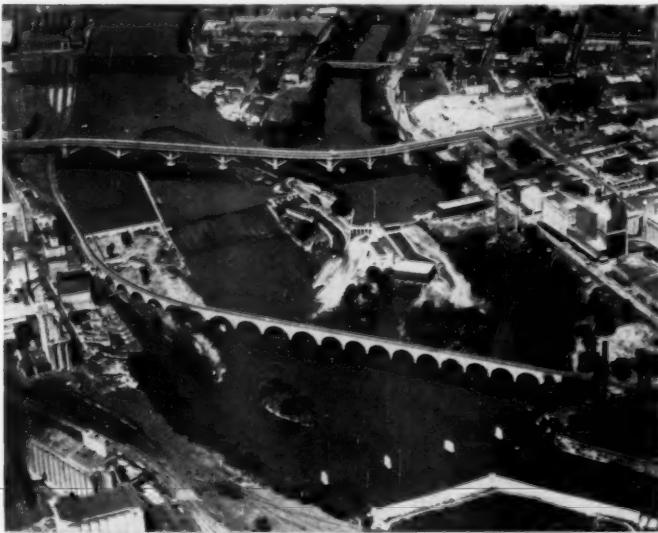
The natural beauty of Minneapolis is breathtaking. The mighty Mississippi, famed the world over as the "Father of Waters," flows sedately through the city, over historic St. Anthony Falls and through gorges cut deep by the centuries. The City has 152 magnificently landscaped parks. With nearly 6,000 acres of park property, the celebrated parkway system almost completely encircles Minneapolis. Deeply wooded Minnehaha Parkway winds along picturesque Minnehaha Creek and links Lake Hiawatha, Lake Nokomis, Lake Harriet, Lake Calhoun, Lake of the Isles and Cedar



Airview of downtown Minneapolis. The Mississippi River is in the background. The Foshay Tower (center of photograph), is designed after the Washington Monument in Washington, D. C.



Beautiful Minnehaha Falls in Minneapolis, immortalized by Longfellow's poem "Song of Hiawatha." Minnehaha Park, where the falls are located, is one of the many fine parks in the city.



Milling district of Minneapolis, with large grain elevators and mills located on both sides of the Mississippi River at St. Anthony Falls. Minneapolis is the third largest flour producing city in the nation and is the home of famous flour mills.

Lake with Minnehaha Park, the home of Minnehaha Falls commemorated in Longfellow's poem, *Song of Hiawatha*. Minnehaha Park itself covers 144 acres of wooded hills, and shelters Stevens House, the earliest home in Minneapolis west of the Mississippi River.

The business district of Minneapolis is impressively and conveniently plotted. Hennepin Avenue, often called the "Broadway of Minneapolis," was named after Father Hennepin, discoverer of St. Anthony Falls. Many of the city's theatres and amusement spots extend along Hennepin Avenue — at night the thoroughfare is ablaze with color beckoning the night farer. Nicollet Avenue, named in honor of another distinguished pioneer, is justly referred to as the "Fifth Avenue of the Upper Midwest." Many fine shops are located on Nicollet Avenue and offer the visitor a pleasant shopping interlude.

For more than 70 years, the flour mills and millers of Minneapolis have been known throughout the world as prime producers of the chief ingredient of bread. It is significant that a flour mill was one of the first structures to be erected on the banks of the Mississippi

River in the little settlement later to become the city of Minneapolis. Today the grain elevators are a tribute to the enormous part the milling industry plays in the life of the city. Minneapolis is headquarters for the five largest wheat flour milling companies in the world — General Mills; International Milling Company; Pillsbury Mills; Russell-Miller Milling Company, and Commander-Larabee Milling Company.

Culturally, Minneapolis offers unparalleled advantages. The University of Minnesota has greatly expanded during and after World War II. Development of the University in the past two decades has placed it among the leading educational institutions in the nation, not only in size, but also in educational standing and national prestige. Minnesota's schools and colleges have long ranked high in health service; namely medicine, dentistry and pharmacy. The University of Minnesota has the Mayo Foundation for Graduate Medical Study and Research affiliated with its medical school. Employing chiefly the training facilities at Rochester, home of the world famed Mayos, this foundation is said to be the largest clinical group of medical students in the world.



Airview of the University of Minnesota campus.

Perhaps the cultural aspect of Minneapolis is best exemplified by the world renowned Minneapolis Symphony Orchestra. This organization, one of the most traveled symphonies in the United States, has brought more fame to Minneapolis than any other cultural institutions. Founded in 1903, the orchestra quickly assumed the role of the leading musical groups in the United States. Its home is in beautiful Northrop Memorial Auditorium on the campus of the University of Minnesota. The Minneapolis Symphony Orchestra has been

recognized throughout Europe as one of the five top orchestras in the world.

Other cultural facilities offered visitors to Minneapolis include the splendid new Walker Art Center, the Minneapolis Institute of Art, the Swedish-American Museum and the University of Minnesota Gallery. These centers regularly exhibit paintings, sculpture, prints, and photography.

Treat yourself and your family. Plan to explore Minneapolis — let Minnesota be yours for a while. Make the Minneapolis meeting your vocation with play!

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Louis B. Newman Receives VA Meritorious Service Award

Louis B. Newman, M.E., M.D., was honored with the **Meritorious Service Award** and **Medal** for 1958, the highest citation conferred by the Administrator of Veterans Affairs, Washington, D. C.

Dr. Newman was cited by Administrator of Veterans Affairs, Sumner G. Whittier, for outstanding service in organizing the PM&R service at the VA Research Hospital and the VA center for rehabilitation of blinded veterans at the Hines VA hospital in Illinois.



Louis B. Newman, M.E., M.D.

The citation reads: "This certificate is awarded to LOUIS B. NEWMAN, M.E., M.D., in recognition of his highly meritorious record of achievements and service in the field of physical medicine and rehabilitation. He has made extensive contributions to medical literature, given generously of his time and talents to voluntary public service and performed his VA duties in a superior manner. He has manifested outstanding ability as a leader, teacher and physician. The VA appreciates the honor he has brought to the agency by his selection as the 1958

'Federal Civil Servant of the Year' in Chicago, Illinois."

Dr. Newman was chosen the 1958 Chicago area Civil Servant of the Year by the Federal Personnel Council. He received the Distinguished Service Award for 1957 from the Illinois Institute of Technology Alumni Association, in recognition of his outstanding contributions to science and medicine. In 1956, he received the John E. Davis Award from the Association for Physical and Mental Rehabilitation.

Dr. Newman is Chief, Physical Medicine and Rehabilitation Service, VA Research Hospital, Chicago, and Professor of Physical Medicine at Northwestern University Medical School. He is President of the American Academy of Physical Medicine and Rehabilitation; Vice President of the American Congress of Physical Medicine and Rehabilitation, and Past Chairman of the Section on Physical Medicine, American Medical Association. He also holds membership in the American Society of Mechanical Engineers, as well as many other professional organizations.



Meritorious Service Medal

He received his degree in Mechanical Engineering from the Illinois Institute of Technology, and his Doctor of Medicine degree from Rush Medical College. He served as commander in the U. S. Navy during World War II.

abstracts

Effect of Air Flow Resistance on Ventilation and Respiratory Muscle Activity.
B. Raymond Fink; Shih-Hsun Ngai, and
D. A. Holaday. J.A.M.A. 168:2245 (Dec.
27) 1958.

The effect of air flow resistance on ventilation and diaphragmatic muscular activity in decerebrate cats before and during anesthesia was measured. The inter-tracheal pressure and the air flow were measured concurrently with EMG recordings of action potentials from the diaphragm and ninth intercostal muscles. There was a proportionate reduction in ventilation with increasing airway resistance in spite of augmented diaphragmatic and intercostal activity. General anesthesia with pentobarbital, nitrous oxide and ether aggravated this ventilatory disturbance.

Home Care for Retarded Children. K. S. Holt. Pediatrics 22:744 (Oct.) 1958.

The author was able to investigate 201 families with retarded children regarding the effect of these children on their homes. It is believed that the most comprehensive list available in Sheffield, England where the study was done, was that of the Local Mental Deficiency Authority. All available families were seen. The cases are well distributed through all social classes and through families of various sizes.

Rather striking information has been documented regarding the adverse effects seen. Almost 20 per cent of the mothers were exhausted physically, with some having been hospitalized. Siblings were attacked in 12 per cent of the cases, several requiring hospitalization for treatment of injuries. Neighbors were a problem for almost three-fourths of the families. Two-thirds of the families were socially isolated.

Some of the findings, family reactions, and possible means of assistance are discussed. She feels that no family visited had made as good physical or emotional adjustments as they might have done even without making major changes of home or environment. Some professional help in making arrangements and adjustments may well be called for. In spite of these problems, home care for retarded children will be necessary and perhaps desirable. The author has given much

information which should help planning and supervising home care programs.

Electroencephalographic Studies of Patients Having Poliomyelitis with no Clinical Evidence of Encephalitic Involvement. H. J. Grossman; E. L. Gibbs, and H. W. Spies. Pediatrics 22:1148 (Oct.) 1958.

One-hundred eleven patients aged six months to 17 years were studied during the acute phase of poliomyelitis. Patients with bulbar involvement were generally studied later in the course of the illness than those who had spinal or non-paralytic disease.

Very abnormal or exceedingly abnormal electroencephalograms were found in 10 of 56 patients with paralytic poliomyelitis, and in 10 of 38 patients with non-paralytic poliomyelitis. Nine of 17 patients with bulbar poliomyelitis showed moderately abnormal tracings, none more severe. It is most likely that the later time of recording (second or third week of illness) necessary because of their condition is responsible for the difference between those having bulbar involvement and those not having it.

Factors Influencing Respiration During Heavy Exercise. Jere H. Mitchell; Brian J. Sproule, and Carleton B. Chapman. J. Clin. Invest. 37:1693 (Dec.) 1958.

The authors studied respiratory data, blood gas concentrations, and pH in men between the ages of 20 and 43 at rest and during heavy exercise. The data show an increase in mean arterial PO_2 and a slight drop in oxygen saturation during heavy exercise, probably related at least in part to changes in arterial pH. Arterial pCO_2 fell during exercise and also during the subsequent period of rest, while pCO_2 in femoral and brachial vein blood rose during exercise and fell during rest. Jugular vein pCO_2 remained relatively constant. Arterial pH fell during exercise, continued to fall for a time following cessation of exercise and failed to return to resting levels in 10 minutes. "Central" blood volume calculated from dye dilution curves indicates an increase paralleling ventilation as exercise of increasing severity was performed.

It is concluded by Mitchell and co-workers, that change of pCO_2 pH, or pO_2 of arterial

blood does not cause the hypernea of exercise, and evidence is cited that it would not be attributable to changes in venous blood unless CO₂ receptors were present in the lungs or right heart. They also conclude that changes in mixed venous pCO₂ and in "central" blood volume may be factors involved in the production of hypernea during heavy muscular exercise.

Variability of Tooth Formation in Man.
S. M. Garn; A. B. Lewis, and D. L. Polacheck. *Science* 128:1510 (Dec. 12) 1958.

The authors have reviewed jaw x-rays of 255 participants of their longitudinal study for the time of beginning calcification, crown completion-root formation, and root completion-apical closure in five mandibular teeth in each individual. The samples used (32 to 96 examples of each stage of development) are small but represent a greater total than apparently was available in previous studies.

The present study shows significantly more variability in the time of each phase of calcification than was previously reported, a matter of some significance to clinicians concerned with establishing developmental age either for legal or diagnostic purposes. If further study shows equally increased range of onset and completion of the formation of deciduous teeth, it may well explain the evidence of "prenatal" dental dysplasia in some children who have had erythroblastosis and other syndromes.

For the physician concerned with the timing of dental development, there is a chart giving the 5th and 95th percentiles of five mandibular teeth, as well as the comparison of these with some of the previously available ranges.

Polyneuritis in Children. N. L. Low. *Pediatrics* 22:972 (Nov.) 1958.

The author reviews the records of 30 children, aged 17 months to 16 years and presenting this syndrome, between the years 1937 and 1956. He includes cases not having high concentration of spinal fluid protein as well as those showing cytoalbuminous dissociation. The name is somewhat misleading, but other names (neuronitis, Schwannitis, Guillain-Barre syndrome, etc.) used for this syndrome or group of syndromes with motor and sensory findings, or a combination of peripheral and cranial nerve signs and symptoms, are no less so.

There is apparently increased susceptibility between ages 4-9 years. One-third showed no prodromal illness. About one-third showed respiratory disturbance and one-third showed gastrointestinal symptoms. The progress of the disease and recovery is quite variable. Recurrences were noted in two patients, one

following an upper respiratory infection and the other following acute otitis media and again following a first poliomyelitis vaccination. Experience elsewhere that recurrences have occurred with fatigue is not mentioned in this study.

Sequelae of Experimental Dislocation of a Weight-Bearing Ball-and-Socket Joint in a Young Growing Animal. W. S. Smith; R. J. Ireton, and C. R. Coleman. *J. Bone & Joint Surg.* 40-A:1121 (Oct.) 1958.

Surgical dislocations of the femur were performed on 16 mongrel dogs ranging in age from two to five weeks by incising the capsule and sectioning the ligamentum teres. In six control animals the same surgical procedure was carried out but the femoral head was left in place. All animals were ambulatory as soon as recovery from anesthesia was complete.

The animals were followed roentgenographically at four-week intervals and were sacrificed when they reached maturity. As early as four weeks following dislocation, acetabular dysplasia was clearly noted in all experimental animals. After eight weeks, the changes in the acetabulum were even more apparent. In the animals in which the femoral head was replaced in the socket after dislocation and section of the ligamentum teres, little, if any, difference could be noted compared with the hip not operated upon.

Post-mortem specimens six months after dislocation showed almost unrecognizable acetabula, while the control specimens showed little difference compared with the side not operated upon. The femoral heads of the dislocated hips were flattened and ovoid compared with those not operated upon and those serving as operative controls. Studies of the angle of anteversion showed in almost every instance of experimental dislocation of the hip, the angle of anteversion was less than that on the control side.

Use of Cutis as an Interposing Membrane in Arthroplasty of the Knee. J. E. Brown; W. H. McGaw, and D. T. Shaw. *J. Bone & Joint Surg.* 40-A:1003 (Oct.) 1958.

The use of a cutis or dermal graft in arthroplasty of the knee joint was first reported by Otto Loewe in 1929. Interest in the use of the cutis was revived in the early fifties when its theoretical disadvantage of epidermoid cyst formation was discredited and the prerequisite of the removal of the epithelial layer was established.

The cutis graft is composed of the derma or true skin with the surface epithelium removed. For arthroplasty the material desired is the deeper layer of derma with a minimum amount of fat but with the deeper, loosely

arranged and more elastic layer. This is composed of collagenous and elastic tissue, blood vessels and epithelial elements, the deeper portion of the hair follicles, sweat glands, and oil glands.

A series of four patients on whom arthroplasty of the knee joint was performed using autogenous cutis graft as an interposing membrane is reported.

The end results after a six-year followup were considered good in all cases "considering the condition of the knees prior to surgery." Range of active motion restored post-operatively varied from 60 to 80 degrees of flexion; extension of 180 degrees was achieved in all cases. Histologically the fate of the cutis graft in the weight-bearing areas is unknown.

Observations on Bacteriostatic and Bactericidal Action of Erythromycin. L. Unger, and A. Kisch. Proc. Soc. Exper. Biol. & Med. 98:176 (May) 1958.

A strain of *Staphylococcus aureus*, very sensitive to erythromycin, was utilized in order to evaluate the bacteriostatic and bactericidal effects of erythromycin. When erythromycin (4 μ g/ml.) was added to a sample of growing bacteria which had reached a population of 10^8 viable units/ml. an increase in turbidity was still noted although significantly less than the control culture. When the culture was diluted to 10^8 organisms/ml. in broth, the drug was rapidly bactericidal.

To explain the difference in effects of erythromycin on heavy and light suspensions of bacteria the culture fluid from heavy suspensions was centrifuged and the supernatants were sterilized. When filtrate from erythromycin-grown cells was added to an equal volume of broth containing erythro-

mycin, the bactericidal action of the drug in low cell densities was depressed though not eliminated. In contrast, the filtrate from cells grown without erythromycin had no effect. Unger and Kisch think that this protective action is most likely the result of decrease of growth rate by the presence of a specific factor, which appears to be released in the presence of erythromycin.

Symposium on the Clinical Significance of Epileptic Seizures Diagnostic Tests, Social Adjustment, and Classification. Donald W. Mulder. Proc. Staff Meet. Mayo Clin. 33:467 (Oct. 1) 1958.

This is a review of 1,284 consecutive patients seen at the Mayo Clinic in 1954 who were presented with the chief complaint of epileptic seizures and who met the clinical criteria as described in "Clinical Examination in Neurology." Data are given regarding the evaluation of diagnostic studies, natural history, and social adjustment.

Of particular interest is evidence corroborating previous reports regarding spontaneous remission, as well as the lesser frequency of seizures in older age groups. Over 80 per cent of the patients seen were at least self-supporting. Less than 15 per cent were partially or wholly dependent. Twenty-five per cent of the patients with onset before the age of 10 years became completely dependent, whereas only rarely did those whose onset occurred past the age of 10 years become dependent. The evidence also indicates that where seizures are associated with atrophic lesions, poor social and vocational adjustment is more likely due to the atrophic lesion rather than the seizures.

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1959 Membership Roster

(See page 179 for Alphabetic Listing)

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Piaskoski, R., Wood, Wis.
Piersol, G. M., Philadelphia
Policoff, L. D., Albany, N. Y.
Polley, H. F., Rochester, Minn.
Polmer, N. H., New Orleans
Prentiss, N. H., Swannanoa, N. C.
Pruce, A. M., Atlanta, Ga.
Psaki, C. G., Philadelphia
Psaki, R. C., Honolulu, Hawaii

Rae, J. W., Jr., Ann Arbor, Mich.
Resnik, J., Beverly Hills, Calif.
Richardson, A. T., London WC 1, England
Rodriguez, A. A., Chicago
Rogers, E. J., Brooklyn
Rogoff, J. B., New York City
Rose, D. L., Kansas City, Kans.
Rosenberg, H., Salt Lake City
Rosenberg, L., Dayton, Ohio
Rothermel, E. W., Reading, Pa.
Rubin, D., Los Angeles
Rudd, E., New York City

Rudd, J. L., Boston
Rudin, L. N., Baltimore
Rudolph, H. L., Reading, Pa.
Rumbaugh, U. D., Kingston, Pa.
Safford, F. K., Vienna, Austria
Samberg, H. H., Des Moines, Iowa
Schaeffer, J. N., Detroit
Schaffer, F. J., Washington, D. C.
Schlesinger, R. A., Broomall, Pa.
Schmidt, W. H., Wynnewood, Pa.
Schmitt, M. G., Chicago
Schram, D. A., Winslow, Wash.
Schwartz, F. F., Birmingham, Ala.
Schwartz, L., Chicago
Selke, O. O., Jr., Houston, Texas
Sherman, S., Pittsburgh
Shields, C. D., Washington, D. C.
Shires, E. B., Kansas City, Kans.
Shriber, W. J., Boston
Silverstein, H., Toronto, Ont., Canada
Smith, E. M., Williamson, W. Va.
Snow, W. B., New York City
Stadin, R., Glendale, Calif.
Stansky, C., Bay Pines, Fla.
Stecher, R. M., Cleveland
Stillwell, G. K., Rochester, Minn.
Stoll, B., New York City
Stoner, E. K., Philadelphia
Strickland, B. A., Jr., Colorado Springs, Colo.
Sverdlik, S. S., New York City

Taylor, V. S., Dallas, Texas
Tepperberg, I., Bronx, N. Y.
Throne, E. M., Silver Spring, Md.
Tobis, J. S., New York City
Tohen Z. A., Mexico, D. F., Mexico
Troedsson, B. S., Minneapolis
Twombly, G. C., Jr., Denver

Ulanski, B., Philadelphia

von Friesen, Tamara, Gallipolis, Ohio
von Werssowetz, O. F., Gonzales, Texas
Vultee, F. E., Jr., Richmond, Va.

Walsh, T. E., Syracuse, N. Y.
Watkins, A. L., Boston
Weems, Rachel F., Fishersville, Va.
Weinstein, M. V., Brooklyn
Weiss, A. A., New York City
Weiss, J., Brooklyn
Weissenberg, E. H., Santurce, P. R.
Welsh, E. C., Wauwatosa, Wis.
White, A. E., Arlington, Va.
Whiting, H. S., Hempstead, L. I., N. Y.
Wiley, B. C., Johnstown, Pa.
Williams, C. B., Ft. Sam Houston, Texas
Williams, G. D., Martinsburg, W. Va.
Wilson, G. D., Asheville, N. C.
Winokur, S., New Orleans
Wise, C. S., Washington, D. C.
Wisham, L. H., New York City
Woll, W. G., Jr., Jamaica Plains, Mass.
Worden, R. E., Los Angeles
Wright, Jessie, Pittsburgh
Wyman, J. F., Milwaukee

Yamshon, L. J., Gardena, Calif.

Zankel, H. T., Durham, N. C.
Zeiter, W. J., Cleveland
Zintek, S. S., Augusta, Ga.

ARTICLE III — MEMBERSHIP

Section 1. Classes of Members. The Academy consists of four types of members with the qualifications, rights and duties hereinafter stated:

- (a) Active Members
- (b) Senior Members
- (c) Honorary Members, and
- (d) Corresponding Members.

Active Members and Senior Members shall be designated as Fellows of the American Academy of Physical Medicine and Rehabilitation.

Section 2. Active Members.

(a) Qualifications. To be eligible for nomination to active membership, a person must be a certificant of the American Board of Physical Medicine and Rehabilitation.

(b) Election. An eligible person may be nominated for active membership by two active members, one to act as proposer and the other as seconder, in writing to the Chairman of the Membership Committee, supplying such information and executing such application or nomination form as the Committee shall require. The Membership Committee shall consider all applications and send to the membership, at least three months prior to the Annual Session, the names of all nominees whom the Committee proposes to present for election as active members. The Committee shall not, however, present for election any nominee concerning whom it has received written objections from ten or more members by at least thirty days prior to the Annual Session, if in the opinion of the Committee, the objections are valid. The nominees presented by the Committee shall come up in Executive Session for election or rejection by the membership. A nominee shall be elected on the favorable vote of two-thirds of the members present and voting.

Section 3. Senior Members.

(a) Qualifications. A person who is 65 years of age or more and who has been an active member in good standing for 15 years or more is eligible to be a senior member.

(b) Election. An eligible person may be elected to senior membership (1) on application to the Membership Committee or (2) on the recommendations of the Committee and on the favorable vote of three-fourths of the members present and voting at any Executive Session of an Annual Session.

Section 4. Corresponding Members.

(a) Qualifications. To be eligible to be a corresponding member, a person must be a legally qualified doctor of

medicine in a country other than the United States or Canada and must have training, experience and recognition comparable to that of a Diplomate of the American Board of Physical Medicine and Rehabilitation.

(b) Election. An eligible person may be nominated for corresponding membership by two members of the Academy, one to act as proposer and the other as seconder, in writing to the Chairman of the Membership Committee, supplying such information and executing such application or nomination forms as the Committee shall require. The Membership Committee shall consider all applications and send to the membership, at least three months prior to the Annual Session, the names of all nominees whom the Committee proposes to present for election as corresponding members. The Committee shall not, however, present for election any nominee concerning whom it has received written objections from ten or more members by at least thirty days prior to the Annual Session if, in the opinion of the Committee, the objections are valid. The nominees presented by the Committee shall come up in Executive Session for election or rejection by the membership. A nominee shall be elected on the favorable vote of two-thirds of the members present and voting.

Section 5. Honorary Members.

(a) Qualifications. Honorary membership may be bestowed on a person whose work in Physical Medicine and Rehabilitation has been so outstanding that he has become renowned nationally or internationally or, to a person who has made some unusual contribution to the field of Physical Medicine and Rehabilitation.

(b) Election. Any active member may suggest to the Chairman of the Membership Committee the name of a person deemed to be eligible for honorary membership, supplying such information and executing such forms as the Committee may require. The Committee shall then, if it deems the person so suggested eligible, nominate him at an Executive Session of the ensuing Annual Session for election on the favorable vote of three-fourths of the members present and voting.

Section 6. Rights of Members. Active and senior members shall have the right to hold office, to vote, and to participate in the Executive Sessions and scientific meetings of the Academy. Corresponding and honorary members shall have all rights and privileges of active members except the right to hold office and vote.

Excerpt from By-Laws, American Academy of Physical Medicine and Rehabilitation, as of August 25, 1958.

ESTABLISH TRUST FUND TO AID THE HANDICAPPED

A first gift of \$100,000 from an anonymous donor established a new trust fund in Chicago to aid physically handicapped persons. The announcement of the new Rehabilitation Institute of Chicago Trust Fund was made by John W. Evers, president of the Commonwealth Edison Company and finance chairman of the Institute.

The four-year-old Rehabilitation Institute last year dedicated two new hospital floors in an expansion of its service to the severely handicapped. The Institute is now equipped to provide all facilities needed in the rehabilitation of physically handicapped persons so that they can return to a more normal and productive life.

Members

Standing Committees of the

American Congress of Physical Medicine and Rehabilitation

1959

Advances in Education

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Harriet E. Gillette
Miland E. Knapp
Harold N. Neu
Elias M. Throne

Awards for Scientific Exhibits

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Herman J. Bearzy
Donald J. Erickson
John H. Kuitert
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Balneology and Health Resorts

Igho H. Kornblueth, *Chairman*
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Boris J. Paul
Edward P. Reese
Edwin Smith

Chronically Ill and Aged

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Edward W. Lowman
Leo Rosenberg

Constitution and By-Laws

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Earl C. Elkins
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Robert C. Darling, *Ex-officio*

Cooperation with Air Force, Army, Navy, Public Health and Veterans Administration

Walter J. Treanor, *Chairman*
Robert V. Miller, Jr.
Arthur E. White
A.B.C. Knudson, *Ex-officio*

Cooperation with Food and Drug Administration

Thomas P. Anderson, *Chairman*
Kenneth C. Archibald
Leo Dobrin
Lucile M. Eising
Donald J. Erickson
Rex O. Morris
David Rubin
Frederick J. Sheffield
George C. Twombly

Correlation of Physical Medicine and Psychiatry

Daniel Dancik, *Chairman*
Allen W. Byrnes
A. Ray Dawson
Lucile M. Eising
Anita M. Isaac
Frazer Parry
William C. Schaefer

Essay Award

(ACPM&R Annual Essay Award
and
Bernard M. Baruch Essay Award)

George D. Williams, *Chairman*
Frederic T. Jung
Gordon M. Martin
Fred B. Moor
George M. Piersol

Ethics

George H. Koepke, *Chairman*
Louis P. Britt
E. C. Christensen
Maxwell D. Flank
Robert M. Krout

Finance

Louis B. Newman, *Chairman*
Everill W. Fowlks
George C. Twombly
Frank H. Krusen, *Ex-officio*

Foster, Encourage and Coordinate Research Projects

Joseph Goodgold, *Chairman*
David I. Abramson
Harvey E. Billig, Jr.
Ralph E. DeForest
Bror S. Troedsson

Gold Key Award

Donald A. Covalt, *Chairman*
Donald J. Erickson
Louis B. Newman
Charles D. Shields
Jerome S. Tobis

Implementation of Departments of Physical Medicine and Rehabilitation in Medical Schools

Joseph G. Benton, *Chairman*
Arthur S. Abramson
James W. Rae, Jr.
William C. Schaefer

Legislation

Bruce B. Grynbaum, *Chairman*
Harold Dinken
Sherburne W. Heath, Jr.
Donald L. Rose
Oscar O. Selke, Jr.
Paul A. Shea
Charles S. Wisc

Medical Auxiliary Services Related to Physical Medicine and Rehabilitation

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Herman J. Bearzy
Donald A. Covalt
Harold Dinken
George M. Piersol
Arthur A. Rodriguez
Bror S. Troedsson

Medical Economics

Arthur A. Rodriguez, *Chairman*
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Joseph E. Cox
S. Malvern Dorinson
Lee B. Greene
Edward M. Krusen, Jr.
William J. La Joie
Nicholas D. Maurillo
Herman L. Rudolph
Paul A. Shea
Leonard J. Yamshon

Meeting Place

Walter J. Zeiter, *Chairman*
Morton Hoberman
H. Worley Kendell
Howard F. Polley
Keith Stillwell
Dorothea C. Augustin, *Ex-officio*

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Otto Eisert, *Chairman*
Hilda B. Case
Carrie E. Chapman
Robert F. Dow
Herbert Kent
Gustave Gingras

Orthoses and Prostheses

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Program

Everill W. Fowlks, *Chairman*
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Glenn Gullickson, Jr.
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Dorothea C. Augustin, *Ex-officio*

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AMERICAN CONGRESS OF PHYSICAL MEDICINE AND REHABILITATION

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States represented: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont and (District of Columbia).

MIDWESTERN SECTION — Chairman, Harold N. Neu, Omaha; Secretary, Adeline B. Gauger, VA Center, Wadsworth, Kans.

States represented: Colorado, Illinois, Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, Wisconsin and Wyoming.

WESTERN SECTION — Chairman, Robert V. Miller, Jr., Los Angeles; Secretary, Carrie E. Chapman, Chief, Physical Medicine and Rehabilitation, VA Hospital, 13th and Harrison Sts., Oakland, Calif.

States represented: Arizona, California, Utah and Territory of Hawaii.

NORTHWESTERN SECTION—Chairman, Duane A. Schram, Winslow, Wash.; Secretary, Sherburne W. Heath, Jr., 757 Medical-Dental Bldg., Seattle.

States represented: Idaho, Montana, Oregon and Washington.

CENTRAL SECTION — Chairman, Rex O. McMorris, Louisville, Ky.; Secretary, Richard F. Baer, 1213 Elco Dr., Maumee, Ohio.

States represented: Indiana, Kentucky, Michigan, Ohio, Virginia and West Virginia.

SOUTHERN SECTION — Chairman, Herbert W. Park, Richmond, Va.; Secretary, Solomon Winokur, 4729 Prytania St., New Orleans.

States represented: Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, New Mexico, North Carolina, Oklahoma, South Carolina, Tennessee and Texas.

3rd International Congress of Physical Medicine
IIIe Congres international de Medecine Physique
3º Congreso internacional de Medicina Fisica
3. internationalen Kongress für Physikalische Medizin

PATRON

The Honorable Richard Nixon
The Vice President of the United States

PATRONESS

Mrs. Richard Nixon

Week of
August 21, 1960

WASHINGTON, D. C., U.S.A.

Preliminary information regarding this meeting may be had from the Office of the Secretary General
WALTER J. ZEITER, M.D., or from the Executive Secretary, DOROTHEA C. AUGUSTIN,
30 North Michigan Avenue, Chicago 2, Illinois.